VOL. 197, NO. 5 MAY 2000

NATIONAL GEOGRAPHIC



IN SEARCH OF VIKINGS

DENMARK'S MYSTERY SHIPS 28 *SILVER QUEEN* 36
NEW CALEDONIA 54 DAWN OF HUMANS 76 ANTS AND PLANTS 84
CAPE HATTERAS LIGHTHOUSE 98 MOUNT ST. HELENS 106

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I come from a long line of people who don't know how to invest.

I'm Josephine, 31.
I run a catering business.
I cook to make people happy
(and myself a little better off).

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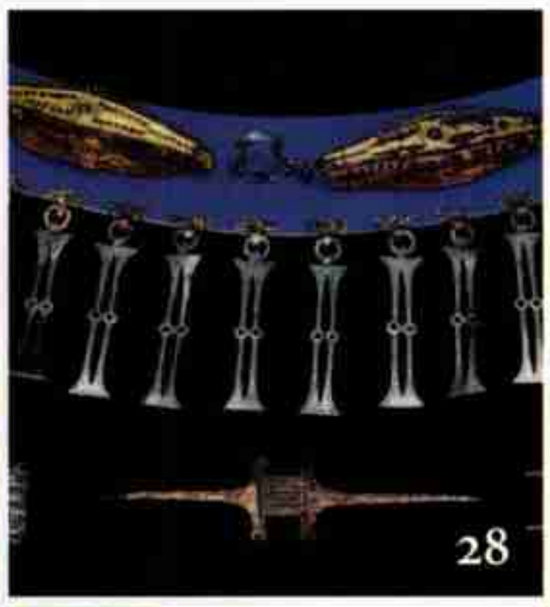
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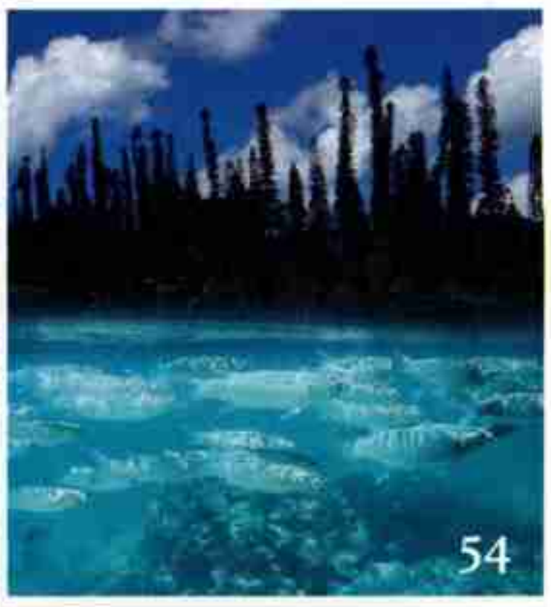
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MAY 2000





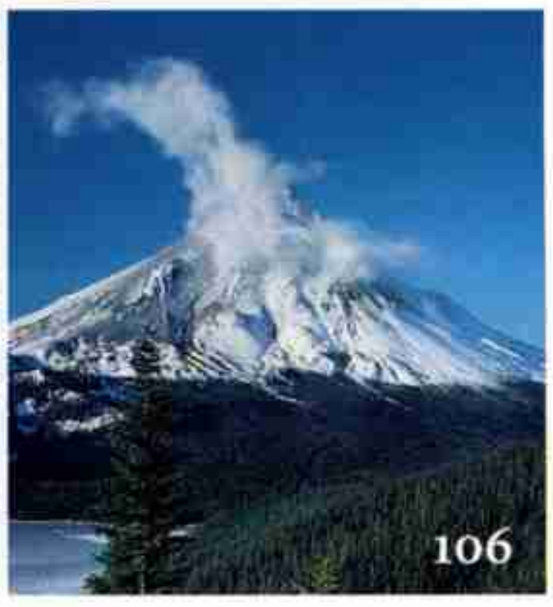












2 **In Search of Vikings** *Viking seafarers—raiders, traders, craftsmen—burst from Scandinavia in the eighth century, carrying their freewheeling pagan ways from the Gulf of St. Lawrence to the Aral Sea.*
BY PRIIT J. VESILIND PHOTOGRAPHS BY SISSE BRIMBERG

28 **Mystery Ships From a Danish Bog** *Sleek, oar-powered vessels teach archaeologists about Scandinavian raiders who were pillaging coastal towns 450 years before the Viking age began.*
BY MICHAEL KLESIUS PHOTOGRAPHS BY SISSE BRIMBERG

36 **Queen of the African Sky** *In 1920 two pioneering aviators completed the first aerial journey from England to the southern tip of Africa. Modern adventurers attempt to reenact this deed of derring-do.*
ARTICLE AND PHOTOGRAPHS BY PETER McBRIDE

54 **New Caledonia** *The Pacific isles of New Caledonia make their mark on the world with a wealth of plant species found nowhere else.*
BY THOMAS O'NEILL PHOTOGRAPHS BY PETER ESSICK

76 **Dawn of Humans** *Exploring the hills close to home, not far from Johannesburg, South African geologist André Keyser made the find of his career—Drimolen, among the richest hominid sites in Africa.*
BY ANDRÉ W. KEYSER PHOTOGRAPHS BY KENNETH GARRETT
ART BY MAURICIO ANTÓN

84 **Ants and Plants** *Tropical "ant plants" recruit armies of loyal insect defenders by providing tasty rations and barracks fit for a queen.*
ARTICLE AND PHOTOGRAPHS BY MARK W. MOFFETT

98 **Cape Hatteras Lighthouse** *This Outer Banks beacon shines again after a half-mile retreat from the advancing Atlantic surf.*
BY ANGUS PHILLIPS PHOTOGRAPHS BY KAREN KASMAUSKI

106 **Mount St. Helens** *Herds of elk now flow past stands of alder 20 years after eruptions ravaged 230 square miles of the Pacific Northwest.*
BY ROWE FINDLEY PHOTOGRAPHS BY JIM RICHARDSON

Departments

On Assignment
Geographica
Forum
On Screen
Earth Almanac
From the Editor

Flashback
Behind the Scenes
CartoGraphic
OnLine

The Cover

Celebrating in bold Viking style, Icelanders in Vestmannaeyjar douse wooden pallets with gasoline, creating a mammoth bonfire as part of a midsummer festival. Photograph by Sisse Brimberg

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On Assignment

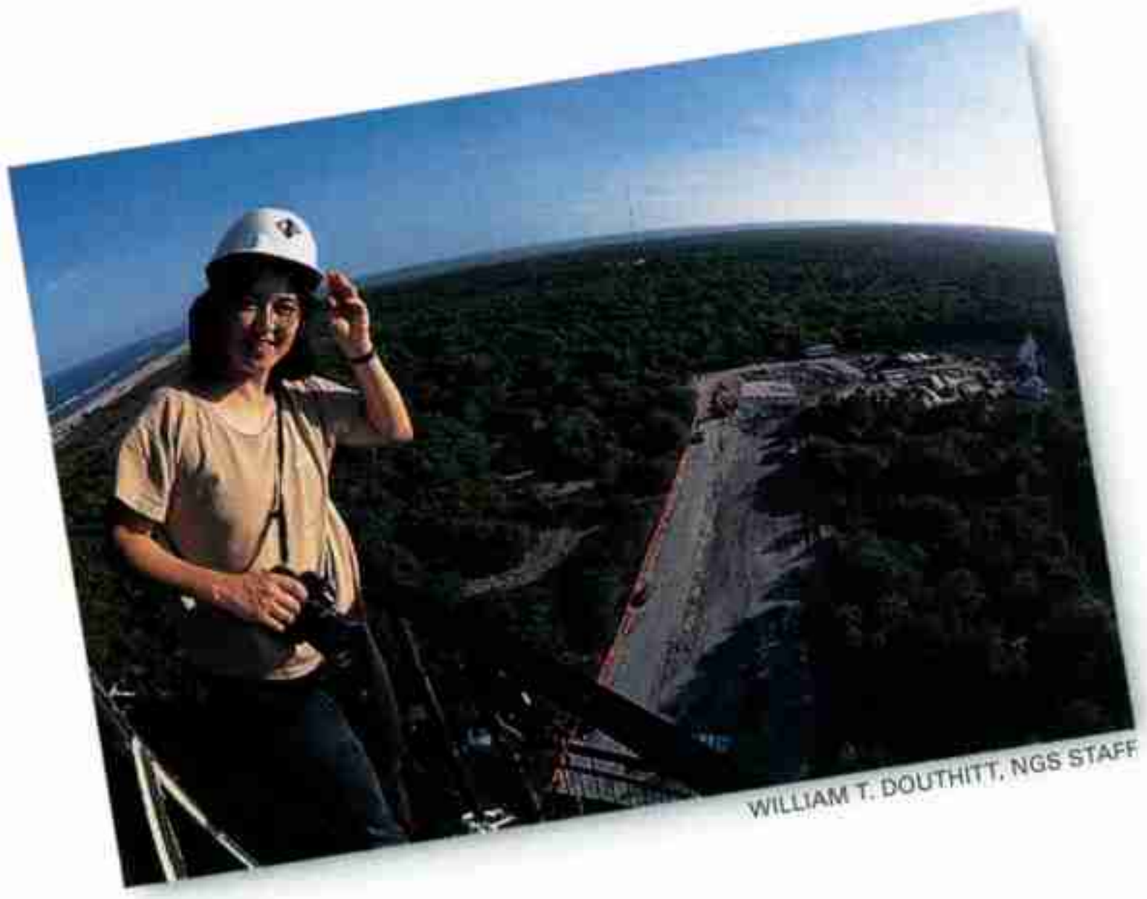


PETER McBRIDE

■ QUEEN OF THE AFRICAN SKY

Heading for High Adventure in a Vickers Vimy

The skies didn't always seem friendly to 29-year-old Peter McBride. Entering Djibouti, the Vimy was intercepted by French Mirage jets. At first Peter feared they were Ethiopian fighters "coming to use us for target practice." Hairy moments aside, "the best part was talking to Samburu warriors, Muslim schoolgirls, and old ladies in Zimbabwe, who all reacted to the plane with total amazement."



WILLIAM T. DOUTHITT, NGS STAFF

■ CAPE HATTERAS LIGHTHOUSE

A View From the Top

Karen Kasmauski has traveled the world taking photographs for NATIONAL GEOGRAPHIC, but last summer her assignment took her just 300 miles south of her Falls Church, Virginia, home. Karen grew up in nearby Norfolk, and the Outer Banks she remembers as a child were much calmer. "Now the area's mad with development fever," she says. It was hot work lugging all her gear up the 257 narrow stairs to the top of the lighthouse, but the view was worth it. "You can see up and down the coastline, away from the congestion. The lighthouse is a last vestige from a classic time."

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ALEXIS DUCLOS, LIAISON

Preserving Philippine Mummies

In the mountainous forests 200 miles north of Manila, a mummified man and child of the Ibaloi people seem to beseech their gods for aid. Logging, vandalism, and rodents threaten 32 mummies that reside in four caves in the town of Kabayan, where the Ibaloi, an ethnic minority, laid to rest tribal leaders and family members from the 10th to 18th centuries. Sometimes, says Orlando V. Abinion of the National Museum of the Philippines, old or ill Ibaloi of high rank readied themselves for mummification by drinking a brine solution to cleanse their organs. Abinion urged the Ibaloi to have these and other mummies photographed as part of a project to preserve and protect them. In 1998 the World Monuments Fund put the Kabayan caves on its list of 100 most endangered sites.



KOREAN INFORMATION SERVICE

Parting the Waters

Tides, not divine intervention, divide the waters around the Korean peninsula's southwestern tip at least once every month, opening a 1.7-mile-long path between Chindo and Modo Islands. The phenomenon has, of course, inspired legends; in one, an old woman on Modo successfully crosses to Chindo to flee pursuing tigers. The "mysterious sea path" reaches an average width of 15 feet in the spring, when some 300,000 people stream across the temporary link as part of an annual festival. The revelers have little time to rest: Within an hour the walkway begins to close.

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Observe the "face of the country, its growth & vegetable productions . . . ," wrote President Thomas Jefferson to Meriwether Lewis in 1803 before he and William Clark set out on their expedition to explore the newly acquired Louisiana territory (GEOGRAPHIC, October 1998).

"Lewis was pretty good as a botanist," says A. E. Schuyler, curator at Philadelphia's Academy of Natural Sciences. "He took a crash course in botany before he left. He knew the terminology and took his professor's textbook." The plants Lewis and Clark brought back—about 80 of them new to science—are taped to 226 sheets in one of the academy's herbaria.

How the collection got there is a remarkable saga: The specimens were split up, spirited off, sold, lost, found, and finally reunited in 1898. Several, such as this page of rabbitbrush specimens, bear Lewis's pasted-in handwritten notes. In this case someone unfortunately affixed Lewis's description, the dark patch, to the wrong page. Time, insects, and rodents—as well as handling by botanists and historians who scribbled comments—have damaged many specimens. The academy recently received a $148,000 grant to install new climate controls to preserve the collection for another 200 years and beyond.



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Geography of Memory

Decades of research with rats had convinced some scientists that long-term spatial memories are retained in the hippocampus, a structure in the temporal lobes of the brain. Larry Squire of the VA Medical Center in San Diego, California, and his colleagues learned otherwise when they examined a 76-year-old amnesia patient whose hippocampus had been damaged by illness. The team probed the patient's



ART BY DIANE FENSTER

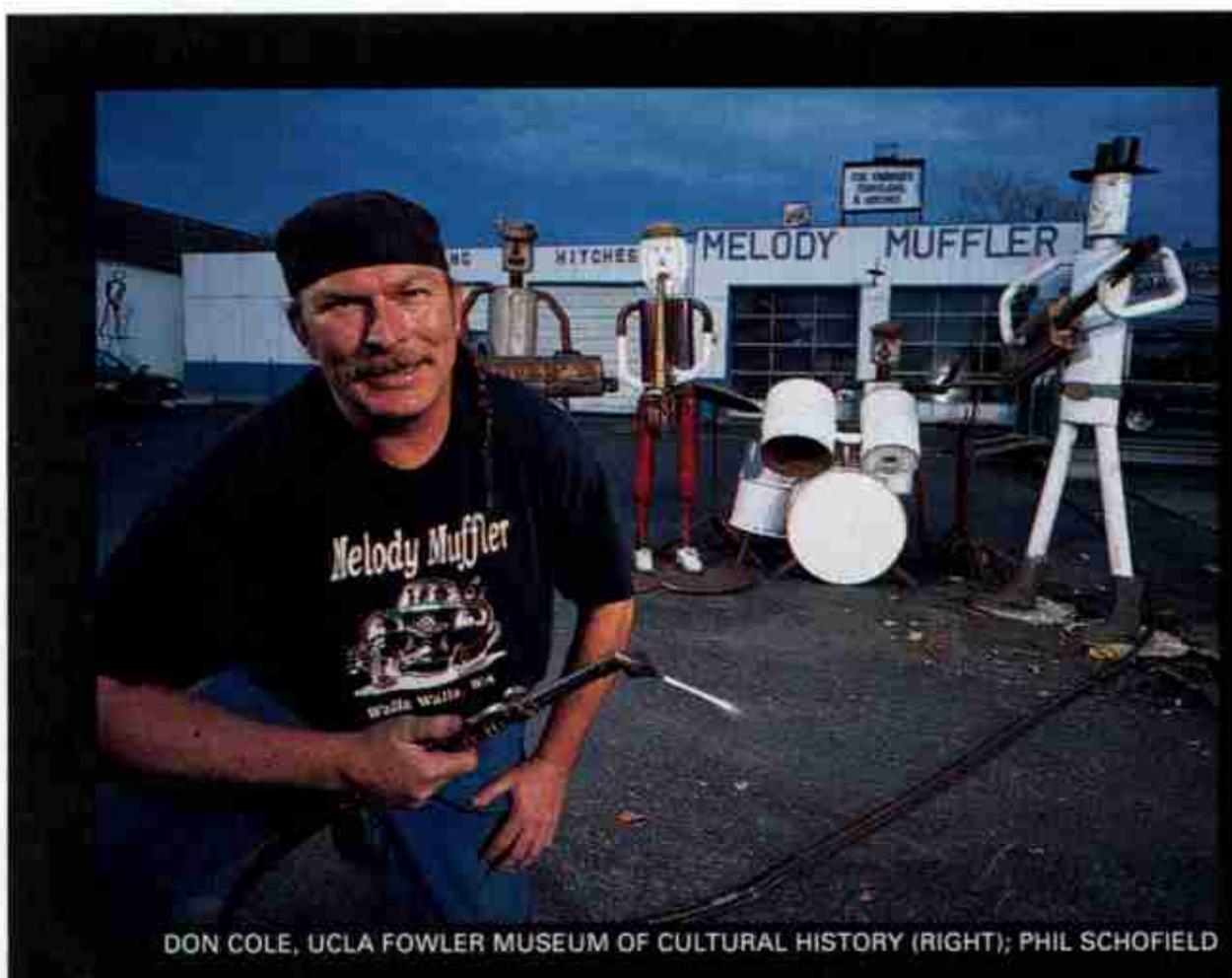
ability to find his way around the area where he lived as a boy, even though "he hasn't retained any information about the neighborhood he lives in now," says Squire. Then he put to the same test five others who had grown up in the area and moved away. The patient performed as well as his former neighbors in mentally navigating his childhood streets. Spatial memories initially depend on the hippocampus, Squire concluded, but eventually they are stored outside that region.

Baha'i Gardens Grow in Israel

New look for a decades-old landmark, terraced gardens on Mount Carmel in Haifa testify to Israel's important place among world religions. The gardens enhance the burial site of a major figure of the Baha'i faith. Eighteen terraces, honoring Baha'i's 18 disciples, cascade down the hill, nine above the shrine, nine below it, all filled with native plants. An Iranian-Canadian Baha'i architect, Fariborz Sahba, designed the gardens, which open to the public next year.



RUHI VARGHA





DON COLE, UCLA FOWLER MUSEUM OF CULTURAL HISTORY (RIGHT); PHIL SCHOFIELD

Not Muffling the Creative Urge

A four-piece rock band wailing outside Mike Hammond's Walla Walla, Washington, muffler shop (above) brings sweet music in the form of customers. Hammond, a drummer himself, has crafted everything from dinosaurs to golfers using old mufflers and spare auto parts. "Repairing mufflers is getting boring after 20 years," he says. "I love to go out and play around with this stuff." UCLA folklorists Patrick Polk and Timothy Correll feature whimsical creations by 17 artists in an exhibit at UCLA's Fowler Museum of Cultural History. The exhibit includes boxers and a Trojan (above right) created by Frank Afra at Affordable Mufflers in Los Angeles.

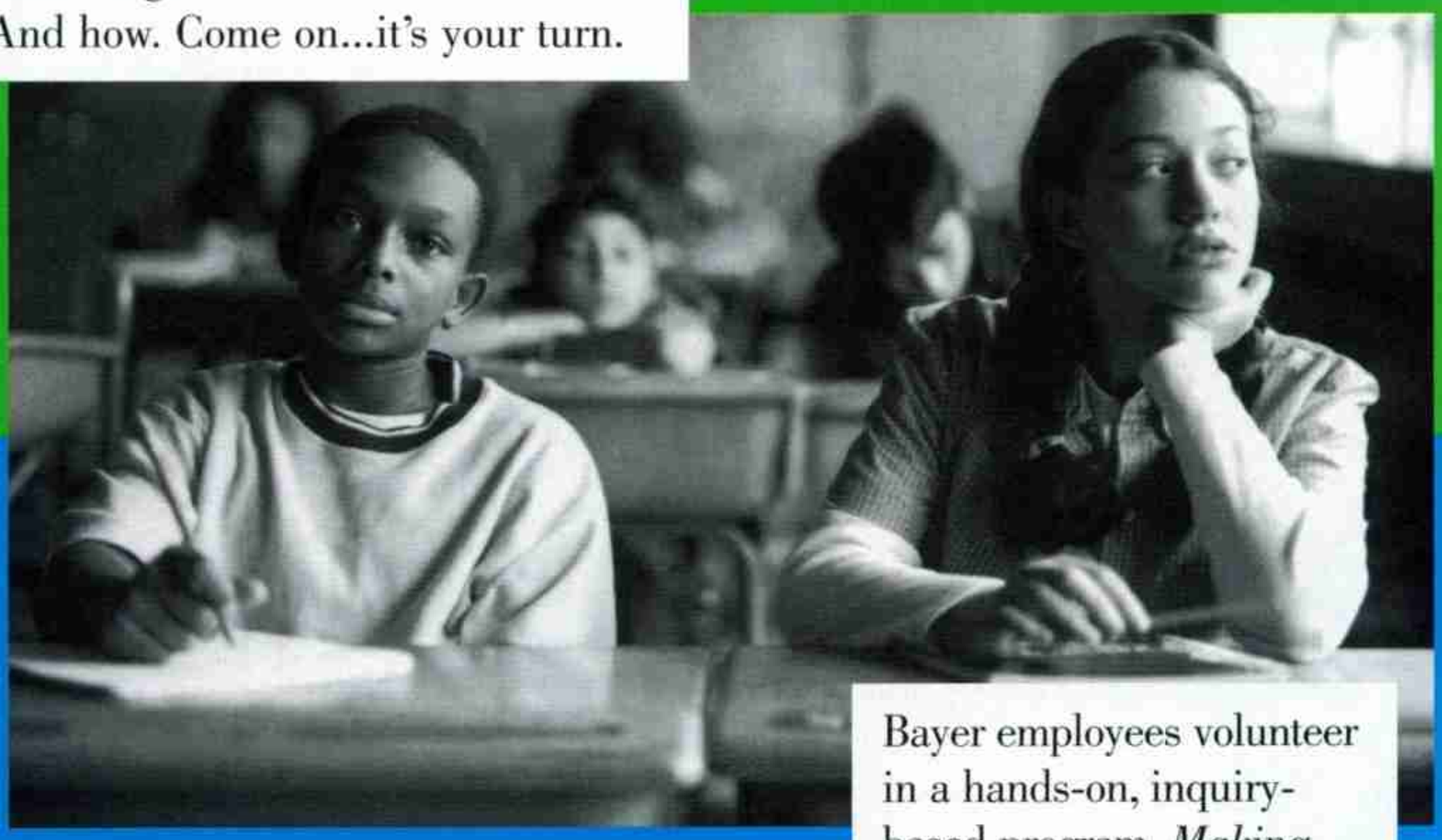
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Forum

The January issue prompted this response from a reader in California: "I treasure the Millennium issue and will see that it is well preserved for my grandchildren. It is important that future generations can look back on life as it existed in the year 2000, and your writers, photographers, and editors deserve the sincerest congratulations for a dramatically presented compendium of that."

Life Beyond Earth

Since life began on Earth billions of years ago, it has adapted to its environment, including the extremes of heat and cold. That does not imply that life could have begun at these extremes. The great unanswered question is whether life could have begun on other worlds having very extreme environments initially.

WILLIAM AND LINDA VIGOR
Lakewood, Colorado

Your article does much to bolster my faith in a Supreme Being who is responsible for the creation and maintenance of the universe in its entirety. There are undoubtedly vast millions or billions of heavenly bodies capable of supporting life of some form, by chance or by some divine reasoning. However, the odds of life creating itself are preposterously low—I choose to believe impossibly low.

ANDY WILLIS
Kimper, Kentucky

The Italian word *canali,* used by Schiaparelli to define what he saw on Mars in 1877, means narrow waterways, natural or artificial. But in English there is a distinction between a natural waterway (the English Channel) and a man-made one (the Suez Canal). Evidently, the translation had an impact in considering the straight lines on the face of the red planet as Martian-made.

FRANCISCO AMPARÁN
Torreón, Mexico

On page 48, Joel Achenbach writes that "Human beings have, by far, the biggest brains on Earth in ratio to body size." Ichthyologists have long known this to be untrue. A group of fishes called mormyrids, or elephant nose fishes, have relative brain sizes that rival or exceed humans. These fishes use weak electrical currents to communicate and navigate in murky waters. It is hypothesized that such an extensive brain is needed to generate this current and interpret the signals and changing electromagnetic field of the fish's surroundings.

DOUG SWEET
Curator of Fishes, Belle Isle Aquarium
Detroit Zoological Institute
Detroit, Michigan

On our planet it took some 3.8 billion years to evolve an intelligent race, which only in the past 50 years or so has been able to send and receive signals from space. Add to this all the other uncertainties in finding extraterrestrial life with at least the same capabilities, and it would seem that the SETI program is a costly exercise in futility.

MYER DIMENTBERG
Montreal, Quebec

The best evidence of intelligent life out there is that none of them have contacted us.

JOHN FISTERE
El Cajon, California

Rediscovering America

A friend and I also hitchhiked across America in the early '70s. The highlight of the trip occurred in Bloomington, Indiana, when a tall, skinny blond guy picked us up and drove us 30 miles out of his way. That tall, skinny blond guy and I will celebrate our 28th wedding anniversary this year. What a great country!

KATHY DEFORD
Omaha, Nebraska

To research the article, Tim Brookes crossed America in large part by hitchhiking, having been given 38 rides. Based on his experience, Mr. Brookes concluded that "surely America is not the violent place it often appears to be on the nightly news." I can think of dozens of dangerous habits that might not carry grave consequences every time but are likely to get you in the end: not wearing seat belts and drunk driving, to name two. The author did something inherently dangerous but was fortunate enough to get away with it.

ERIC SCHWENT
Madison, Wisconsin

While the phrase "half throttled by freeways" is an apt description of Walnut Creek, the phrase "but it seemed that my only hope of reaching the West Coast without having to walk was to rent a car" shows that things are often not as they seem. Alongside one of those city-choking freeways lies one of the best rapid-transit systems in the country. Had the author but walked half a mile or so to the Bay Area Rapid Transit system, he could have taken a quick, comfortable ride to Oakland for under three dollars.

STEVEN BURNAP
Walnut Creek, California

Tibet Embraces the New Year

I enjoyed the article on Tibet's New Year, but I was surprised to find no mention of the Chinese occupation and the less-than-ideal conditions under which Tibetans live.

PHIL SQUIRE
Åby, Sweden

The Enigma of Beauty

The article's juxtaposition of freakishly tall and thin women models (the average woman stands 5′4″) and the beauty industries' revenues of tens of billions of dollars is telling indeed. There is no money to be made by celebrating the variety of actual human beauty. Instead, the bucks come

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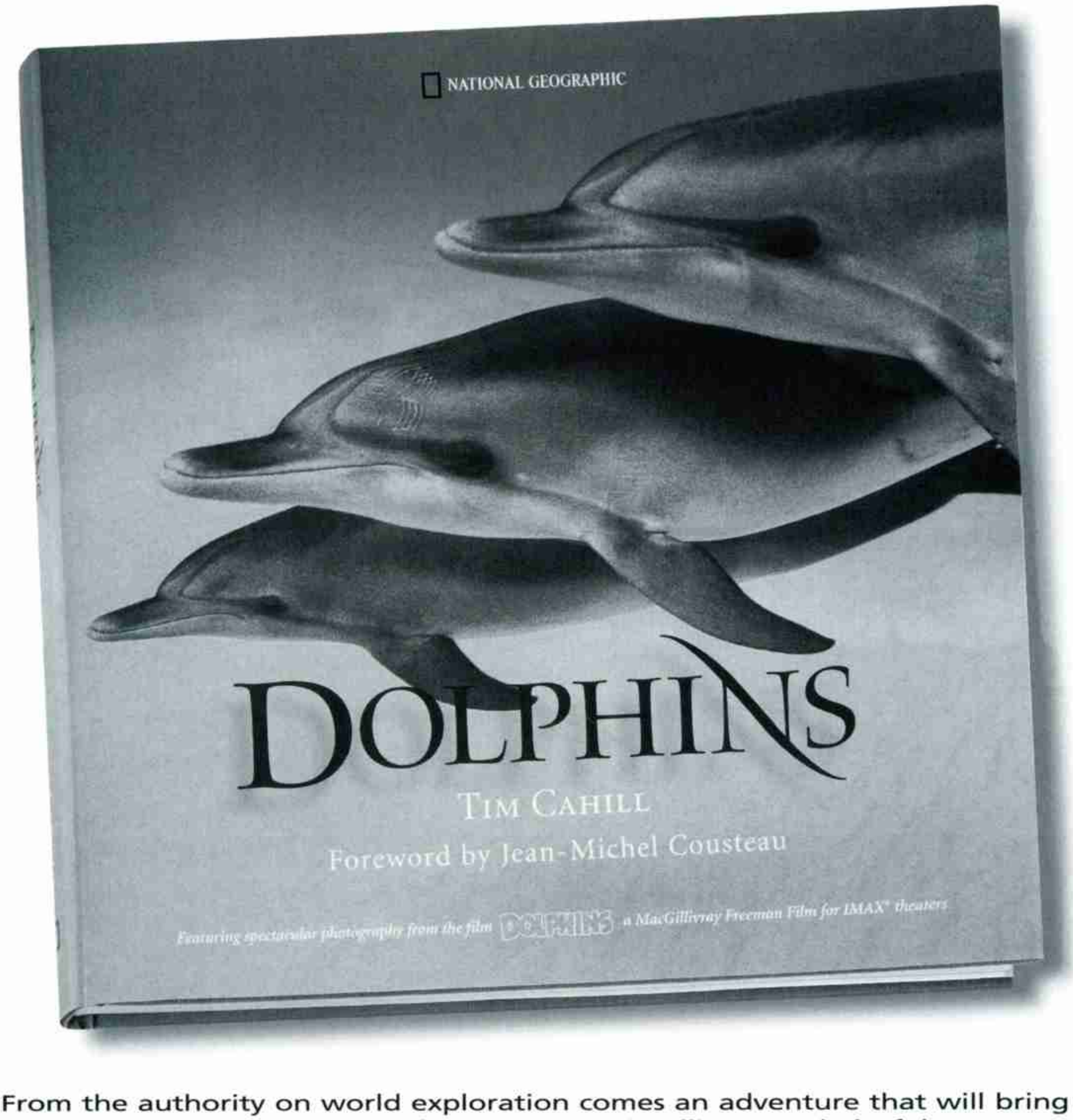
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from persuading people, mostly women, that they are inadequate and then selling them some paint or potion that promises to cure that inadequacy. "Beauty," when treated this way, is an Orwellian horror.

BARB PARCELLS
San Diego, California

The current quest for beauty reminds me of the eugenics movement a century ago. The fact that beauty is described by the evolutionary scientists cited in the article as a sign of fertility is strikingly similar to the classification of who was "fit to breed" and who was not. If eugenics was a pseudoscience in the past, I am afraid it will gain respectability because of the genetic evidence that will be provided to demonstrate that one person is inferior to another.

ALEXANDRE PAQUIN
Montreal, Quebec

I was reading about the role of hair in beauty when my wife and daughter returned from their appointments with the hairdresser. My 12-year-old daughter's hair was about nine inches shorter. I expressed the standard Dad compliments about the new look and kept my regrets to myself. Later my wife told me what had happened. On the way to the hairdresser, my daughter asked how much eight inches of hair was. She had read about a group called Locks of Love that would take human hair of at least eight inches to make a wig for a girl with cancer. (They now require ten inches.) Now I see the beauty that was hidden in her hair.

MATT TRACY
Liberty, Missouri

I am wondering if there have been changes in the geography of my people since my school days. The article states on page 108 that "to grow long hair among the Ashanti in Nigeria made one suspect of contemplating murder. . . ." The Ashanti are not from Nigeria, they are Ghanaians.

DANIEL AKWEI
Newark, New Jersey

The problem of poor body image and the "beauty myth" is one that young men are facing as well. In the same way Barbie espouses the tall, thin woman, GI Joe has grown from an average 150-pound male into a steroid-laden, juiced-up superhulk. More and more of our young men are spending hours weight-lifting to gain impressive pectorals that are useful only to impress.

JOSH FEDERSPIEL
Assistant Cross Country, Track and Field Coach
California State University
Chico, California

I continue to get the GEOGRAPHIC for its wonderful photographs of human beings in all walks of life. You will find beauty in the slums of Calcutta, in the wizened face of a nomad cradling her baby from the desert sands, in a scientist searching for a cure. This is true beauty.

RUTH HOUSMAN
Newton Centre, Massachusetts

Light in the Deep

By the time I finished reading the article on beauty, I was despondent, contemplating my physical flaws and the limits they impose on me. Then I turned the page and stared at the underwater photography of David Doubilet, and I realized the irony. The ultimate price of our obsession with personal appearance may be the way it can blind us to the real abundance of beauty in the world.

KAS RAY BADIOZAMANI
Seattle, Washington

I've been reading your magazine all my life. Across the magnificent chaos of subjects and places, there is a line of work that has made a tremendous impact in my life. Mr. David Doubilet, words are too short to thank you.

MANUEL DELGADO AZORÍN
Mexico City, Mexico

When I unwrap my NATIONAL GEOGRAPHIC, I always browse through it just to get a first impression. My procedure has not varied for more than 20 years. When I flipped through the January issue, my eyes rested on the most beautiful pictures I have ever seen. My first thought was: David Doubilet.

ED BRAND
Lelystad, Netherlands

Geographica

Regarding your report on a newly discovered horoscope prepared by German astronomer Johannes Kepler, let us hear what Kepler himself had to say about making horoscopes: "I have only devised horoscopes when I was sure that my work was intended for somebody who understands philosophy and is not affected by contradictory superstition."

VALERIE VAUGHAN
Amherst, Massachusetts

CartoGraphic

When I looked at the map of the Internet, I was struck with an almost physical reaction that the graphic is undoubtedly what the map of connections in the human brain looks like in simplified form. It seems to be one more confirmation of how random and nonlinear our world is.

PAUL SANSOUCY
Liverpool, New York

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If you are a premenopausal woman who is not ovulating, you should know that *Avandia* therapy may result in resumption of ovulation, which may increase your chances of becoming pregnant. Therefore, you may need to consider birth control options. Talk to your doctor before taking *Avandia* if you are nursing, pregnant or thinking about becoming pregnant.

While taking *Avandia*, follow your doctor's guidelines for periodic liver monitoring. If you experience nausea, vomiting, stomach pain, tiredness, anorexia, dark urine or yellowing of the skin, talk to your doctor immediately. Tell your doctor if you have a history of congestive heart failure or edema. Please see important patient information on the following page.

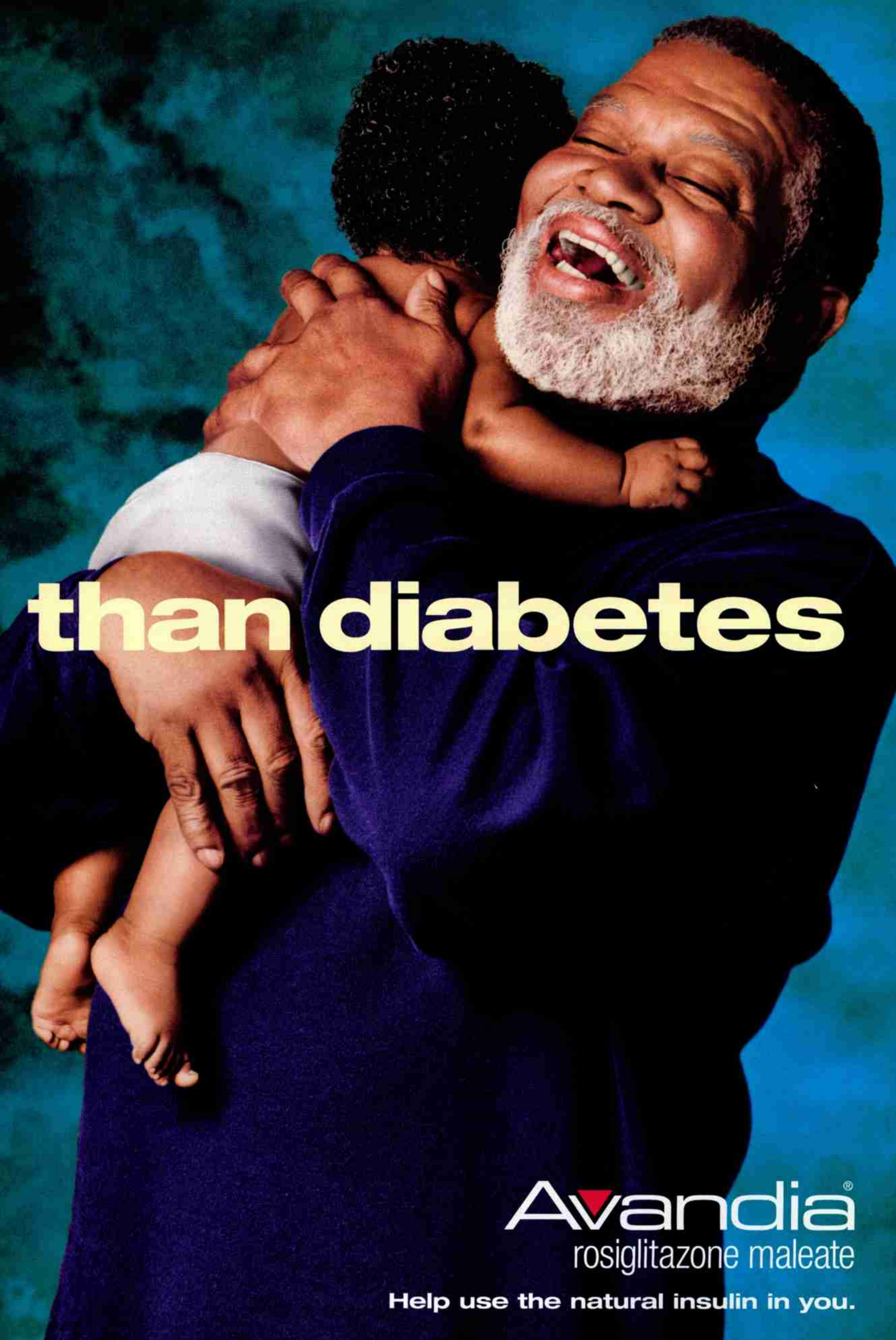
For improved blood sugar control, follow the diet, exercise, weight-loss and medication plan recommended by your doctor and test your blood sugar regularly.

If you have type 2 diabetes, talk to your doctor.
Or for more information, call 1-800-AVANDIA.
www.avandia.com

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What is *Avandia*?

Avandia is one product in a new class of prescription drugs called thiazolidinediones (thigh-a-zoe-lid-een-die-owns). It is used to treat type 2 diabetes by helping the body use the insulin that it is already making. *Avandia* comes as pills that can be taken either once a day or twice a day to help improve blood sugar levels.

How does *Avandia* treat type 2 diabetes?

If you have type 2 diabetes, your body still produces insulin but it is not able to fully use the insulin. Insulin is needed to allow sugar to be carried from the bloodstream into many cells of the body for energy. If insulin is not being used correctly, sugar does not enter the cells very well and builds up in the blood. If not controlled, the high blood sugar level can lead to serious medical problems, including kidney damage, blindness and amputation.

Avandia helps your body use insulin by making the cells more sensitive to insulin so that the sugar can enter the cell.

How quickly will *Avandia* begin to work?

Avandia begins to reduce blood sugar levels within 2 weeks. However, since *Avandia* works to address an important underlying cause of type 2 diabetes, insulin resistance, it may take up to 12 weeks to see the full effect. If you do not respond adequately to your starting dose of *Avandia*, your physician may increase your daily dose to improve your blood sugar control.

How should I take *Avandia*?

Your doctor may tell you to take *Avandia* once a day in the morning or twice a day in the morning and evening. It can be taken with or without meals. Food does not affect how *Avandia* works. To help you remember to take *Avandia*, you may want to take it at the same time every day.

What if I miss a dose?

<u>If your doctor has prescribed *Avandia* for use once a day:</u>

- As soon as you remember your missed dose, take one tablet anytime during the day.
- If you forget and go a whole day without taking a dose, don't try to make it up by adding another dose on the following day. Forget about the missed dose and simply follow your normal schedule.

<u>If your doctor has prescribed *Avandia* for use twice a day:</u>

- As soon as you remember the missed dose, take one tablet.
- Take the next dose at the normal time on the same day.
- Don't try to make up a missed dose from the day before.
- You should never take three doses on any single day in order to make up for a missed dose the day before.

Do I need to test my blood for sugar while using *Avandia*?

Yes, you should follow your doctor's instructions about your at-home testing schedule.

Does *Avandia* cure type 2 diabetes?

Currently there is no cure for diabetes. The only way to avoid the effects of the disease is to maintain good blood sugar control by following your doctor's advice for diet, exercise, weight control, and medication. *Avandia*, alone or in combination with other prescription drugs, may improve these other efforts by helping your body make better use of the insulin it already produces.

Can I take *Avandia* with other medications?

Avandia has been taken safely by people using other medications, including other antidiabetic medications, birth control pills, warfarin (a blood thinner), Zantac® (ranitidine, an antiulcer product manufactured by Glaxo Wellcome Inc.), certain heart medications, and some cholesterol-lowering products. You should discuss with your doctor the most appropriate plan for you. If you are taking prescription or over-the-counter products for your diabetes or for conditions other than diabetes, be sure to tell your doctor.

What should I discuss with my doctor before taking *Avandia*?

You should talk to your doctor if you have a history of edema, liver problems or congestive heart failure, or if you are nursing, pregnant or thinking of becoming pregnant. If you are a premenopausal woman who is not ovulating, you should know that *Avandia* therapy may result in the resumption of ovulation, which may increase your chances of becoming pregnant. Therefore, you may need to consider birth control options.

What are the possible side effects of *Avandia*?

Avandia was generally well tolerated in clinical trials. The most common side effects reported by people taking *Avandia* were upper respiratory infection and headache. As with most other diabetes medications, you may experience an increase in weight (3 to 8 pounds). This often occurs with improved blood sugar control. *Avandia* may also cause edema and/or anemia. If you experience any swelling of your extremities (e.g., legs, ankles) or tiredness, notify your doctor.

Who should not use *Avandia*?

The following people should not take *Avandia*: People with type 1 diabetes, people who experience yellowing of the skin with Rezulin® (troglitazone, Parke-Davis), people who are allergic to *Avandia* or any of its components and people with diabetic ketoacidosis.

Why are laboratory tests recommended?

Your doctor may conduct blood tests to measure your blood sugar control. In addition, your doctor may conduct liver enzyme tests. *Avandia* did not show signs of liver problems in studies. However, because a related drug (*Rezulin*) has been associated with such problems, and because *Avandia* has not been widely used, your doctor may recommend a blood test to monitor your liver before you start taking *Avandia*, every 2 months during the first year and periodically thereafter.

It is important that you call your doctor immediately if you experience nausea, vomiting, stomach pain, tiredness, anorexia, dark urine, or yellowing of the skin.

How should I store *Avandia*?

Avandia should be stored at room temperature in a childproof container out of the reach of children. Store *Avandia* in its original container.

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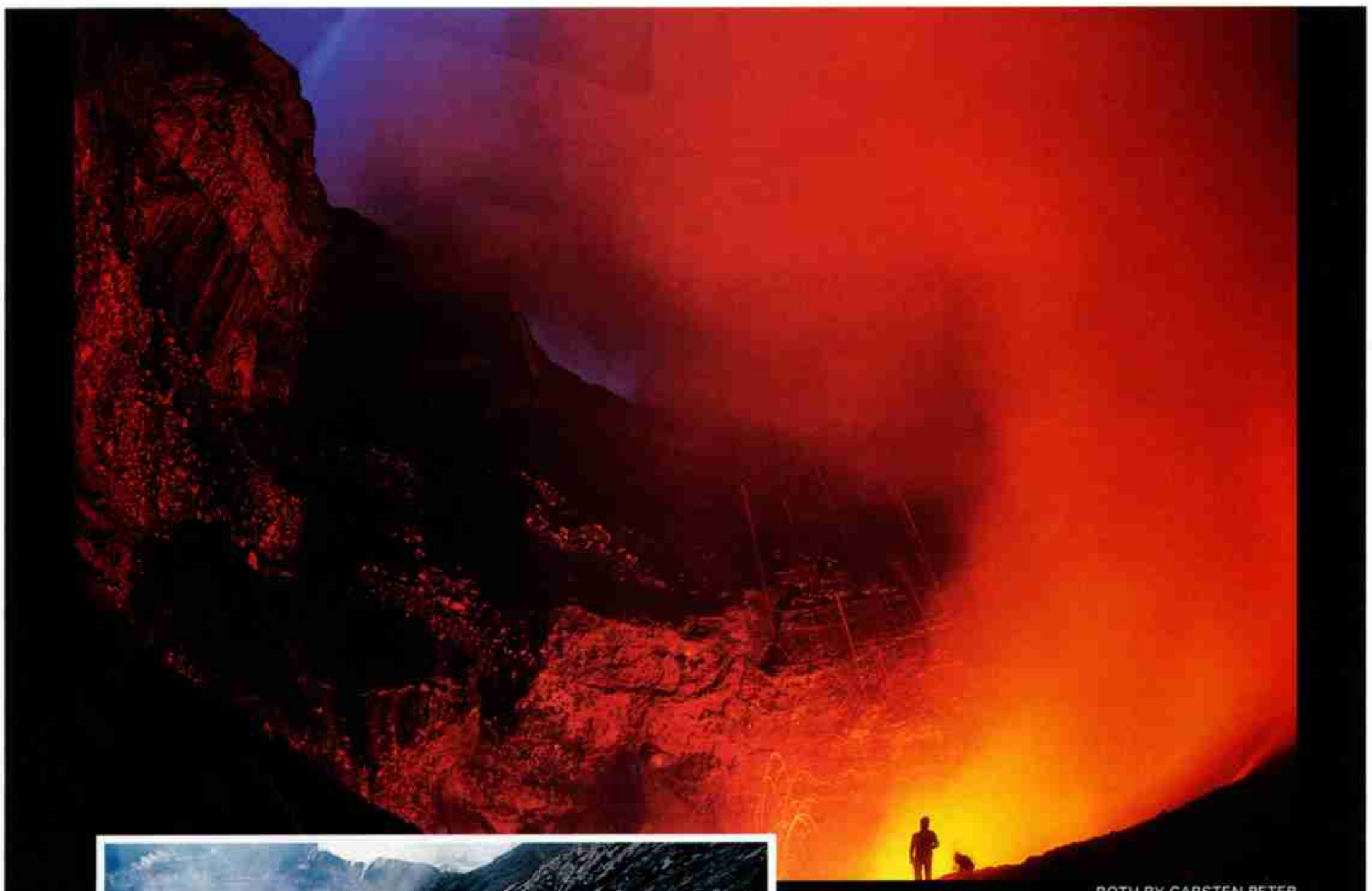
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■ EXPLORER, MAY 7

Into the Volcano

A fiery lake of magma sets aglow members of an expedition into the vast caldera of Ambrym, a volcanic island in the Pacific Ocean nation of Vanuatu. The story of this trouble-plagued foray led by photographer Carsten Peter appears on EXPLORER this month. "The molten earth rumbles under its own weight as it flows," says Peter, "and the ground quakes." Gases, lava projectiles, and rockfalls were a constant danger as team member Franck Tessier (inset) descended 1,500 feet into the crater. Just two months after the crew departed, a powerful earthquake struck the area, triggering landslides and a tsunami.



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NO PURCHASE NECESSARY TO ENTER. A PURCHASE WILL NOT IMPROVE YOUR CHANCES OF WINNING. 1. HOW TO ENTER: 1) Complete Official Entry Form, or 2) follow instructions for ordering a Canine Seat Belt to be automatically entered, or 3) on a 3.5" x 5" plain piece of paper, print your name, age, address, city, state, zip code and daytime phone number and mail to: CESAR® SELECT DINNERS® Brand "Little Dogs Dream Big" Sweepstakes, P.O. Box 812, Ellenton, FL 34222-0812. Sweepstakes begins March 31, 2000. ALL ENTRIES MUST BE RECEIVED BY JULY 31, 2000. No mechanically reproduced, incomplete, illegible, forged or altered entries will be accepted. Sponsor and judges not responsible for lost, late, misdirected, incorrect, damaged or postage-due entries. Enter as often as you wish but mail each entry separately. Entries become the exclusive property of the Sponsor and will not be returned. **2. SELECTION OF WINNER:** Winner will be determined from all eligible entries received in a random drawing on or about August 18, 2000, by Ventura Associates, Inc., an independent judging organization whose decisions are final on all matters relating to this Sweepstakes. Odds of winning depend on the number of eligible entries received. Winner will be notified by mail. Winner must accept prize and provide social security number and may be required to sign an Affidavit of Eligibility and Liability/Publicity Release. Prize may be awarded to alternate winner if Affidavit is not returned within 14 days after mailing to winner or if prize notification letter or prize is returned as undeliverable. Winner agrees to use of winner's name, hometown and likeness and/or prize information for purposes of advertising, promotion and publicity in any medium without additional compensation to the extent permitted by law. **3. PRIZE:** One Grand Prize: A 2000 BMW Z3 roadster, 2.3 base model with standard equipment (estimated M.S.R.P. $32,000) or cash alternative of $25,000. Winner must take delivery from local/nearest dealer. Winner is responsible for title, tags, license and registration fees, must have a valid driver's license and provide evidence of insurance at time vehicle is awarded. **PRIZE WILL BE AWARDED.** Sponsor reserves the right to substitute prize of equal or greater value. No other substitution or transfer of prize permitted. Sponsor responsible only for prize delivery, not responsible for prize utility, quality or otherwise. **4. ELIGIBILITY:** Sweepstakes open to individual legal residents of U.S. (excluding territories and possessions), 18 years of age or older as of July 31, 2000, except employees of Kal Kan Foods, Inc., participating retailers, their respective affiliates, agents, judges and advertising, production and promotion agencies, Ventura Associates, Inc., and the immediate families and members of the same household of each. This offer is void where prohibited or restricted by law and is subject to all applicable federal, state and local laws and regulations. All taxes, fees and other expenses not specified herein are the sole responsibility of the winner. By participating in this Sweepstakes, each entrant accepts the conditions stated in these Official Rules, agrees to be bound by the decisions of the judges and warrants that she/he is eligible to participate in this Sweepstakes. By accepting prize, winner agrees to release Sponsor, its directors, employees, officers, and agents, including without limitation its advertising and promotion agencies, from any and all liability, loss or damages arising from, or in connection with, the awarding, receipt, and/or use or misuse of prize or participation in any prize-related activities. **5. WINNER'S NAME:** For the name of prizewinner, send a S.A.S.E. before July 31, 2000, to: CESAR® SELECT DINNERS® Brand "Little Dogs Dream Big" Sweepstakes Winner, P.O. Box 582, Ellenton, FL 34222-0582. Winner's name will be sent after selection of winner. DO NOT SEND ANY OTHER CORRESPONDENCE TO THIS BOX NUMBER. **6. SPONSOR:** Kal Kan Foods, Inc., 3250 E. 44th Street, Vernon, CA 90058-0853. ©2000 Kal Kan Foods, Inc. CESAR, SELECT DINNERS and the Tray Design are registered trademarks. The BMW name and logo are registered trademarks.

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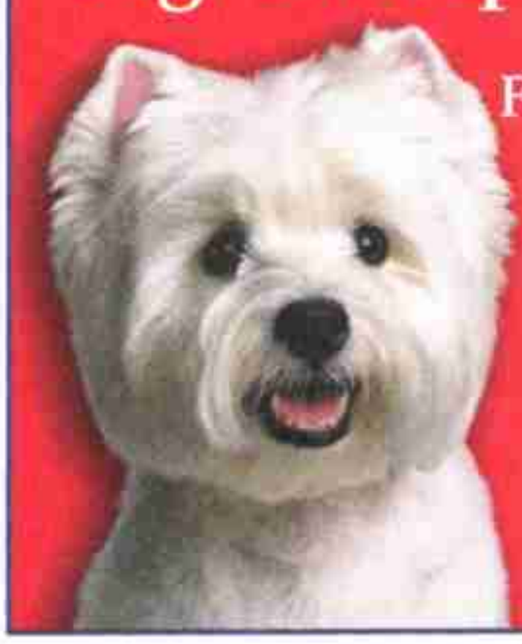
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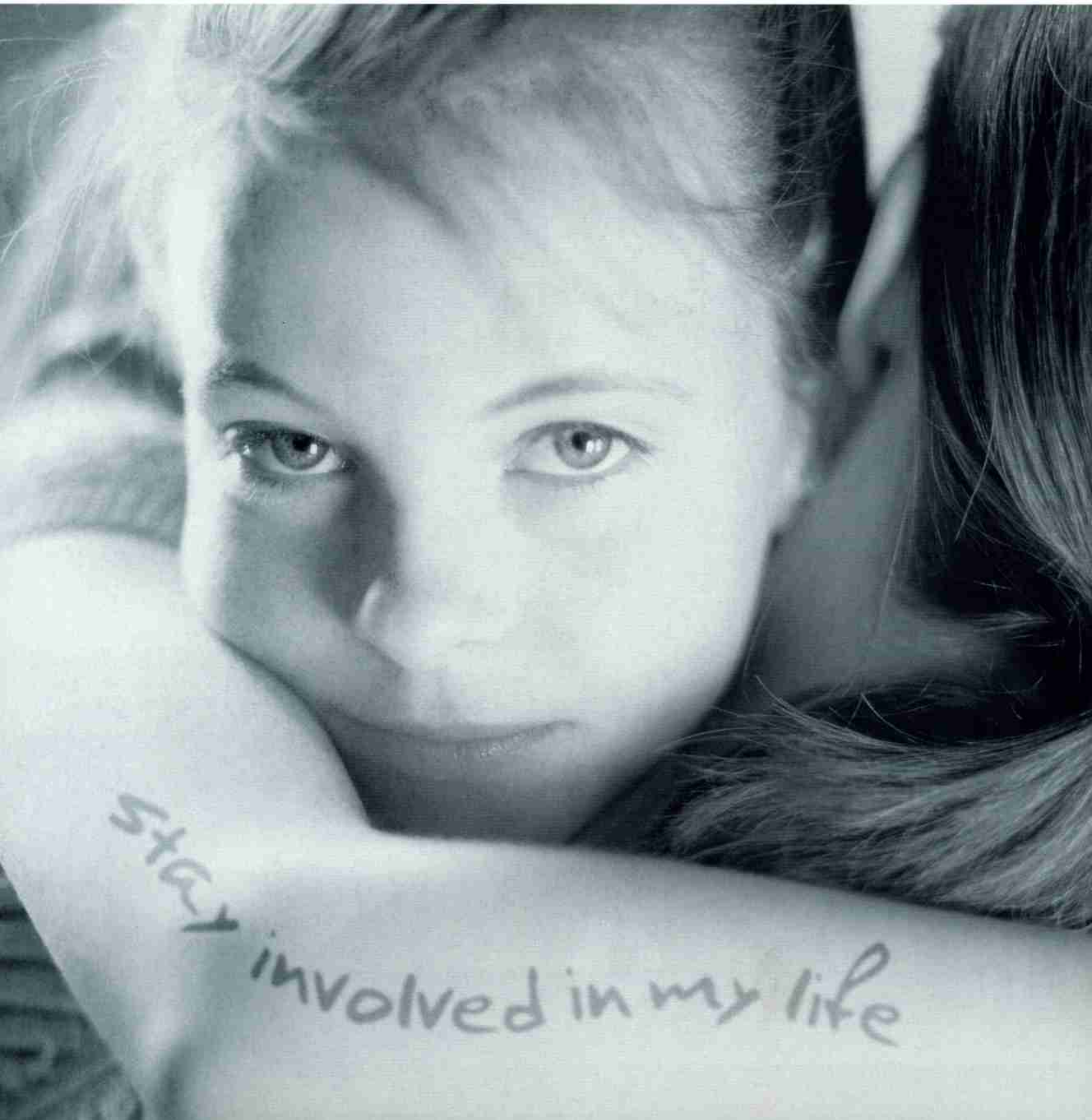
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JOHN FORD

Contaminated: PCBs Plague British Columbia's Killer Whales

Found in industrial products like transformers, toxic PCBs were banned for most applications by the U.S. and Canada in the mid-1970s. Yet today PCBs have been detected in killer whales off British Columbia. Peter Ross of the Institute of Ocean Sciences tested 47 orcas, residents that eat mostly salmon as well as transients that feed on marine mammals. "The PCBs may come from leaking dumps or may be deposited from the atmosphere into the ocean," says Ross. The orcas averaged PCB levels two to five times as high as beluga whales exposed to industrial pollution in the St. Lawrence River (GEOGRAPHIC, June 1994).

Reducing Paint Fumes: A Volatile Question

In the Los Angeles area, despite aggressive antismog programs, ten million people breathe some of the dirtiest air in the United States, say local officials. One surprising culprit—paint. As they dry, paints and related products release 60 tons a day of volatile organic compounds



ART BY DAVE CUTLER

(VOCs) into the air, contributing to the region's smog. That is equivalent to the smog-forming emissions of 1.8 million of L.A.'s six million vehicles. Officials have tightened restrictions on VOC emissions from paint over the past two decades, and recently approved regulations will help bring levels to their lowest point yet, removing 22 tons a day of VOCs by 2006.

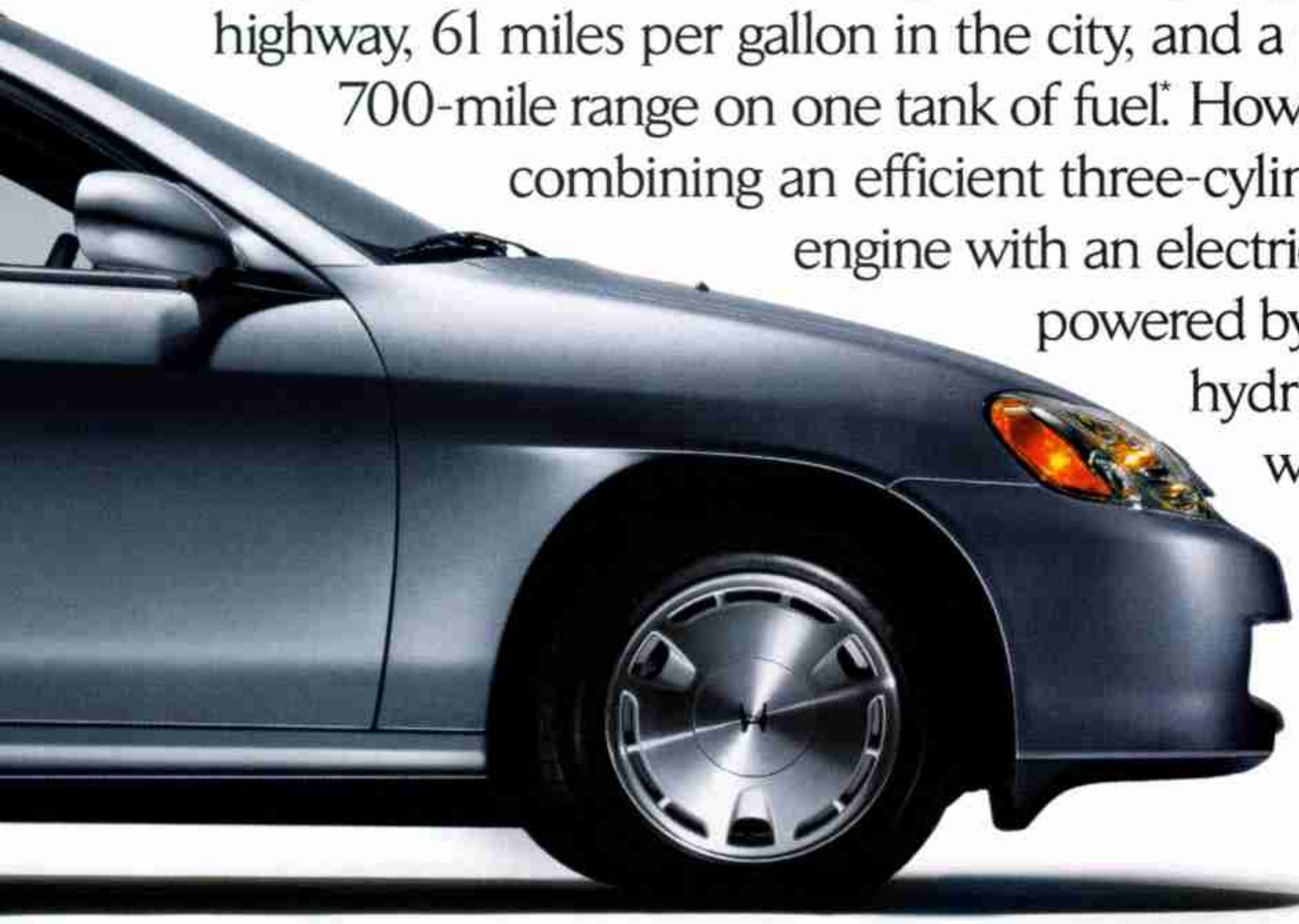


*Mileage figures based on EPA estimates. Actual mileage may vary. Range based on EPA highway mileage. †California Air Resources Board ULEV-certified for California and some Northeastern states. LEV-certified in rest of country. ©1999 American Honda Motor Co., Inc. www.honda.com

It's an environmental movement all by itself.

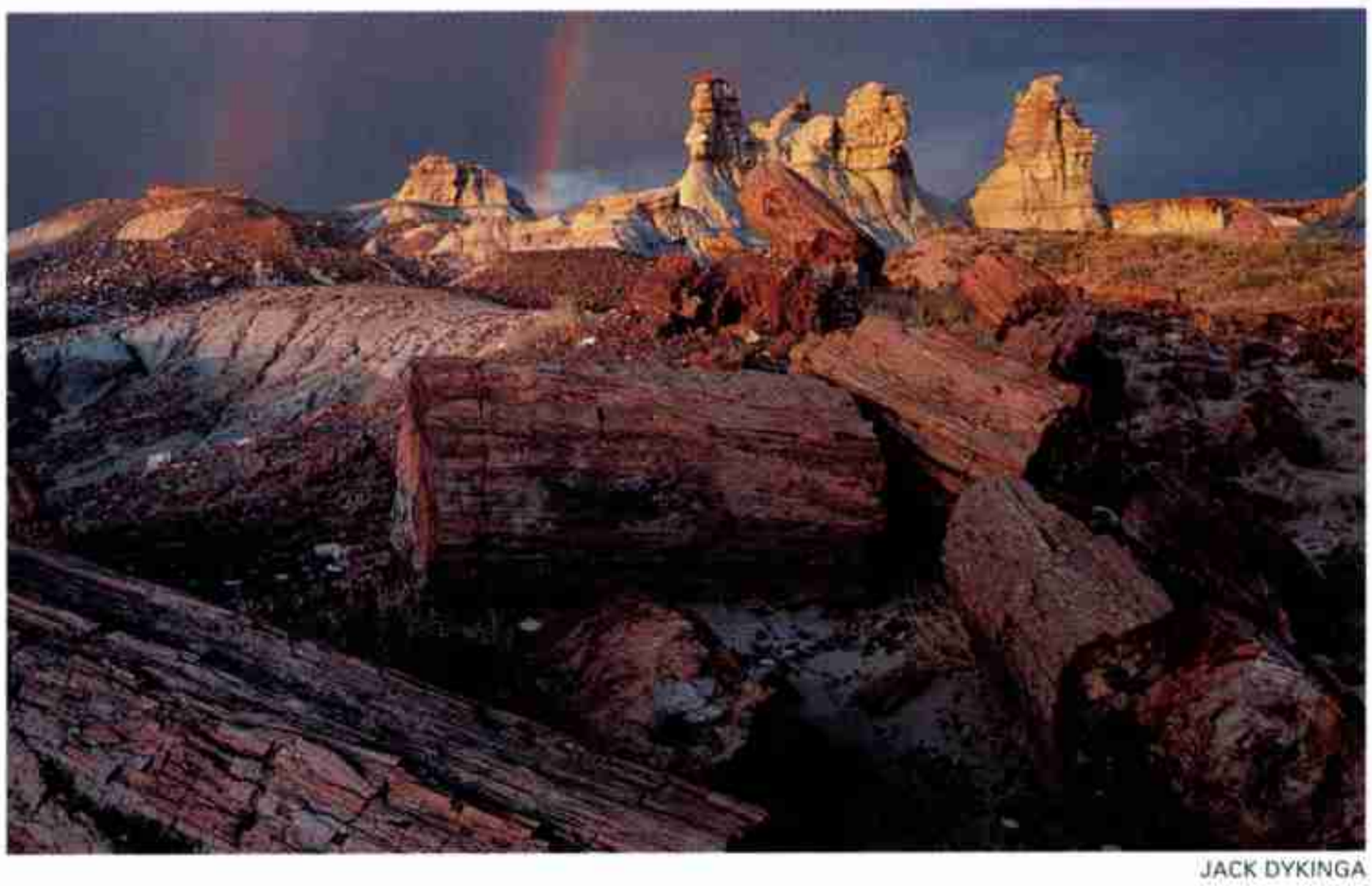
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A Lovely Park, Easy to Get Carried Away



JACK DYKINGA

Since the late 1800s, people have been helping themselves to a geologic treasure in northeastern Arizona—a petrified forest. Some 225 million years ago conifers here were felled by floodwaters. Their woody tissues eventually were replaced by quartz. Early entrepreneurs exploited the petrified logs. Boxcarfuls were shipped east to make furniture, and logs were dynamited in search of gems.

In 1906 Petrified Forest National Monument was created under the newly passed Antiquities Act. It became a national park in 1962 and has grown to 93,533 acres. But such protection hasn't stopped all pilferage. Each year perhaps 12 tons of petrified wood leaves the park illegally. In 1998, 64 visitors were fined a total of $24,000, "including a man with 440 pounds in his van," says assistant chief ranger Greg Caffey. Some pieces are returned in a steady stream of mail. "People have had some for 60 years—others are from kids whose parents make them write apology letters."



THEODORE FLEMING

■ NGS RESEARCH GRANT

A Moth and a Cactus Made for Each Other

In Mexico's Sonoran Desert, a delicate dance between the senita moth and the senita cactus was discovered by University of Miami biologist Theodore Fleming. During the spring and summer blooming season successive generations of egg-laying moths pollinate the cactus flowers, which then become fruit whose seeds are eaten by moth larvae. Late hatching larvae hole up in cactus branches to wait for spring.

Cactus flowers open only at night, when the moths are active. In cool weather early rising bees may find open blossoms, but on warm nights the bars close by dawn—and pollination is all up to the moths.

■ NGS RESEARCH GRANT

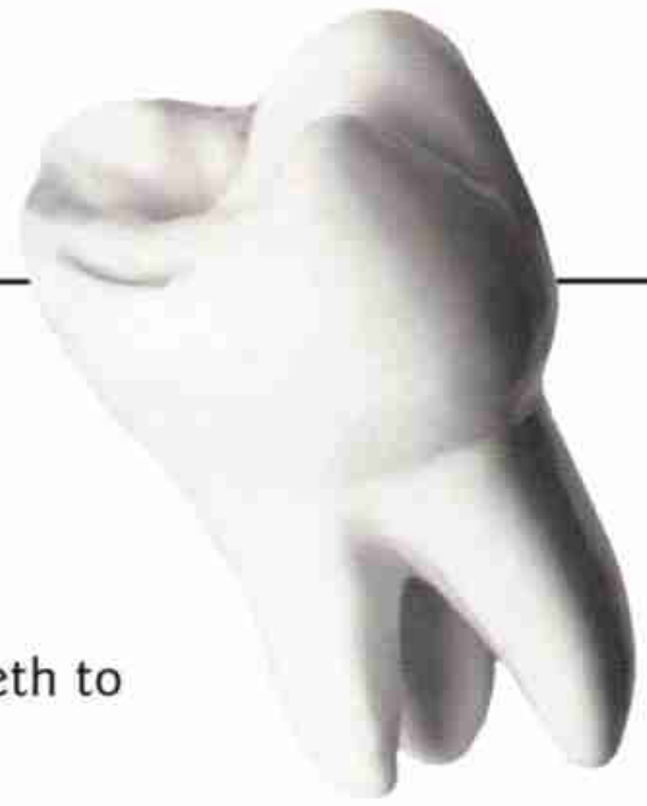
Monkeys Adjust

Seeking extra cash in the pet trade, 18th-century slavers carried African mona monkeys abroad. On far-flung islands—São Tomé and Príncipe off Africa and Grenada in the Caribbean—loose pet monas thrived in the wild. Now more than 2,000 descendants populate each area, says anthropologist Mary Glenn, who studies the long-term results when a few animals multiply in an isolated habitat.



HEATHER BRUCE

Getting Students' Attention Used To Be Like Pulling Teeth.



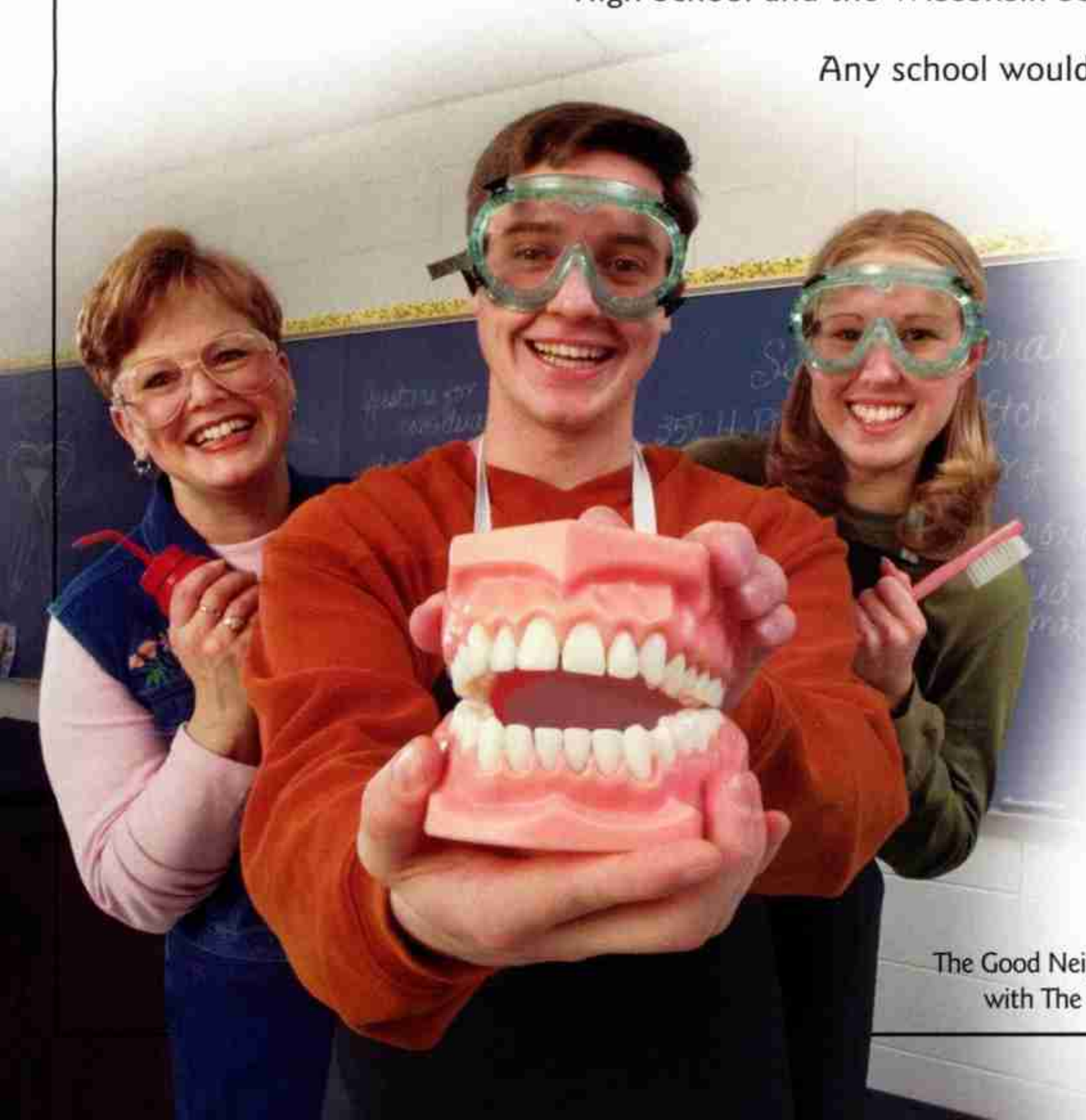
But that was before Sharon Nelson came up with the ingenious idea of letting her chemistry students seal teeth to learn firsthand how chemical bonding works.

With the help of a local dentist and his hygienist, Ms. Nelson turned her classroom into a dental lab. Students performed a variety of procedures, introducing them to chemical bonding in a way easy to relate to and understand.

They were also able to see the cooperation it took among these professionals, both inside and outside the school, to make this learning experience possible. Besides providing good role models for students, it underscored the importance others in the community placed on their education.

For creating such positive chemistry, State Farm is pleased to present Ms. Sharon Nelson with our Good Neighbor Award® and to donate a total of $5,000 to Waunakee High School and the Wisconsin Society of Science Teachers.

Any school would give its eyeteeth for a teacher like Ms. Nelson.



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Flapper Alerts South African Birds to Wires

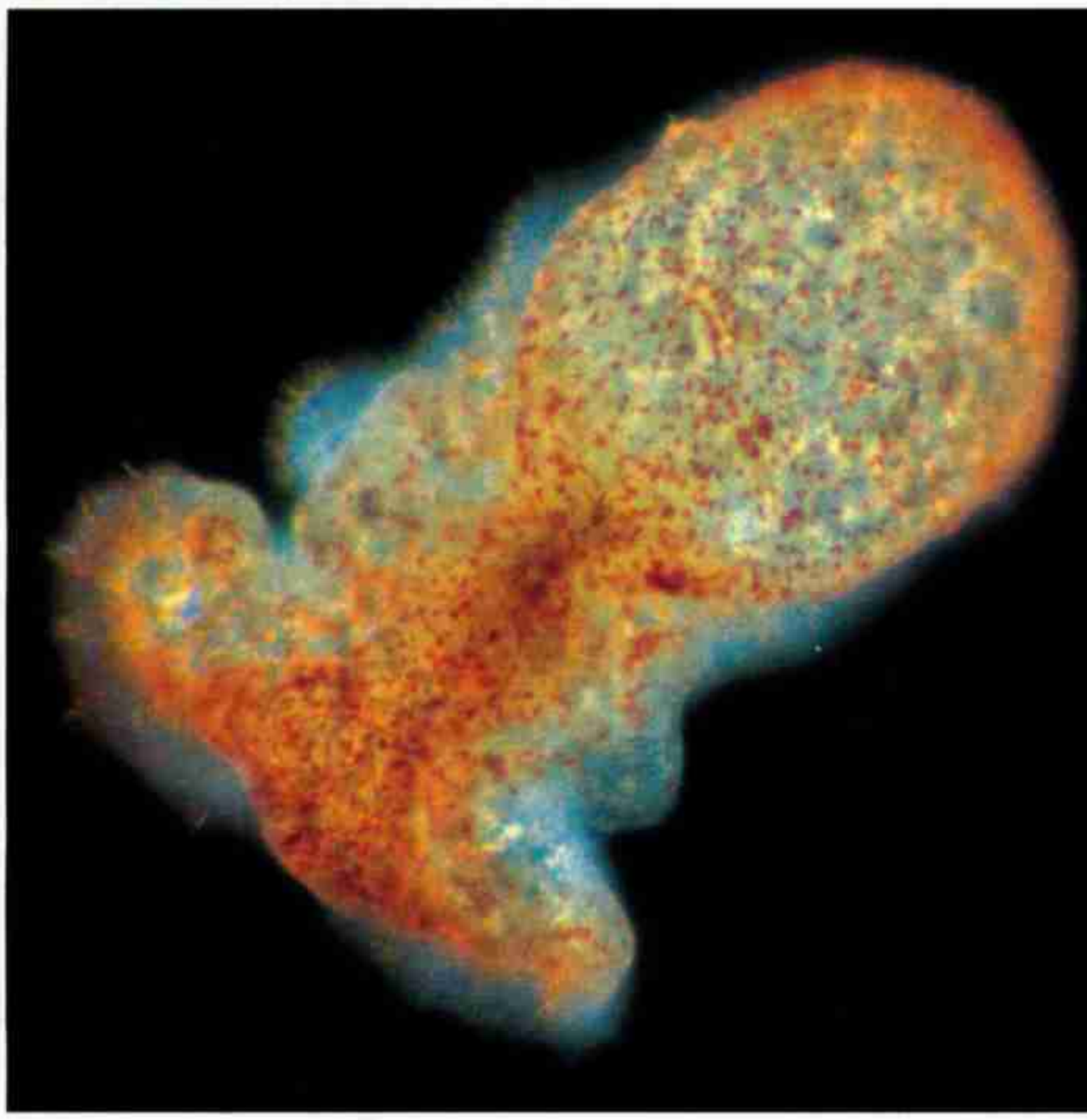
Power lines can often mean death to birds, but South Africa's electrical utility, Eskom, is cutting down the carnage. To make the wires easier to see, Eskom and the Endangered Wildlife Trust are using a simple device called the bird flapper (right). It is clipped onto power lines, making them more visible as it flaps in the breeze. This little egret (left) died by impact, although some victims are electrocuted.



Rare wattled cranes, whose numbers in South Africa have shrunk to just 250, have also been killed by power lines, as have blue cranes, grey crowned cranes, and Ludwig's bustards. Twenty flamingos were being killed annually at one roosting site. When bird flappers were tested there, the landowner reported that they reduced mortality by 75 percent over a two-year period.



BOTH BY CHRIS VAN ROOYEN



Sea Urchin Hybrid—Evolutionary Blueprint

How do animals' body plans evolve and develop? In unexpected ways. When evolutionary biologists Rudolf and Elizabeth Raff of Indiana University cross-bred two closely related species of sea urchins, they ended up with a hybrid (left) that didn't resemble the larvae of either species. Instead it looked remarkably like the larva of an ancestor from which sea urchins and starfish diverged some 450 million years ago. "This shows that there is an older pattern of larval formation still present in sea urchins," says Raff. He doubts that the hybrids could survive outside the lab.

ELIZABETH AND RUDOLF A. RAFF

Britain's Snakes Losing Ground

Tradition holds that St. Patrick drove the snakes out of Ireland. England is also thin in the reptile department—it has only three snake species, including 18-inch-long smooth snakes like this mating pair. Adders and grass snakes are the others. Smooth snakes are plentiful in spots. "I can see more on a morning in Dorset than any snake in any rain forest," says herpetologist Tony Phelps. But development has reduced their habitat, lowland heath, by 85 percent in the past hundred years.

TEXT BY JOHN L. ELIOT



TONY PHELPS, BBC NATURAL HISTORY PICTURE LIBRARY

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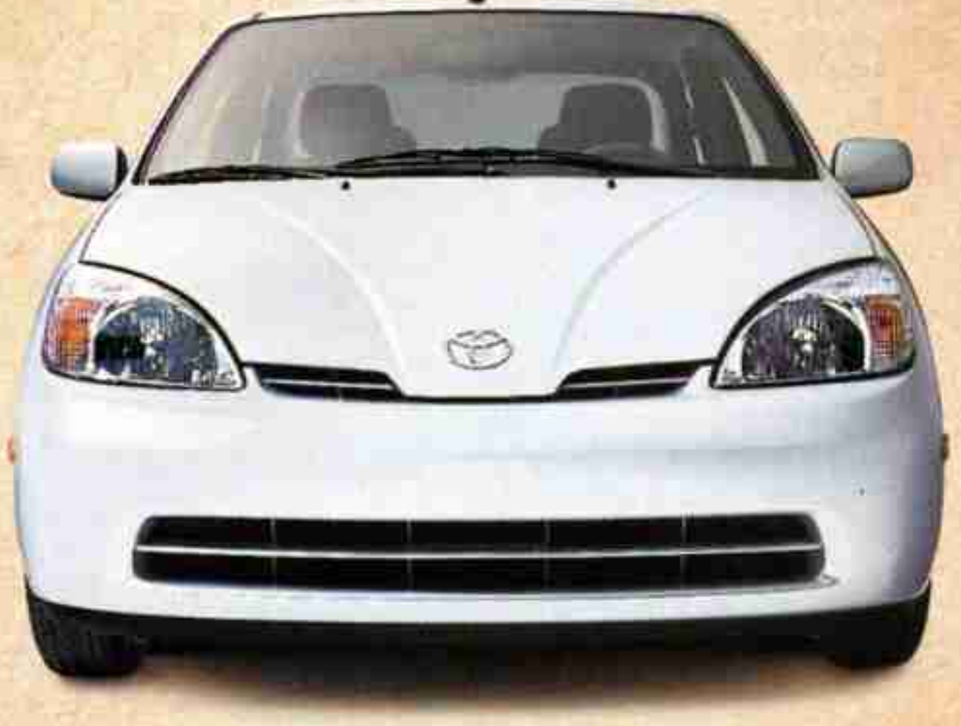
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NATIONAL GEOGRAPHIC



STEVE RAYMER (ABOVE); JIM RICHARDSON

From the Editor

IT WAS A SIMPLE MEMORIAL to a simple man. Not long after the eruption of Mount St. Helens 20 years ago this month, author Rowe Findley (above) visited the marker commemorating Harry Truman, the stubborn old man who died in his lakeside lodge rather than run from the mountain. Rowe, working on our article about the volcano, had become friends with Harry, as well as with photographer Reid Blackburn, who also was lost in the blast.

"I'd been covering Mount St. Helens ever since the first tremors, so I'd been there, I knew the people and their families," recalls Rowe. In fact, during a recent return to the mountain with his wife, Virginia (right), Rowe called on Blackburn's widow, Fay, and her family. Such involvement in a story is not unusual. Our writers and photographers spend months, even years, on an assignment, and while they never sacrifice their professionalism, they often develop lasting friendships.

"It was the most memorable story I ever worked on," says Rowe, who has written 18 GEOGRAPHIC articles. "And those people will always be part of my life."



Bill Allen

A FIERCE GRAVITY ENERGIZES

Norway, a force that seems as palpable as wind or fire or ice. You can feel it as you drive from Bergen, on a road chiseled into sheer cliffsides, to the Sogne Fjord. You can feel it especially in spring, when melting snowfields become torrential streams that thunder into waterfalls and the water in the deep and ragged ocean inlets seems to pull, as if the gravity had bottomed out and pivoted to

HORSE-HARNESS ORNAMENT, NATIONAL MUSEUM OF DENMARK, COPENHAGEN

VIKINGS

IN SEARCH OF



BY PRIIT J. VESILIND
NATIONAL GEOGRAPHIC SENIOR WRITER



A thousand years ago Viking ships carried traders, settlers, and raiders west to America, south to Italy, and east to Russia. Scandinavia's power would never be greater. In time the expeditions dwindled and the Norse joined Christian Europe, but their ways live on in parts of the former Viking dominion. On Vestmannaeyjar, Icelanders celebrate at midsummer as did their forefathers

—with fire, song, and plenty to drink.

PHOTOGRAPHS BY SISSE BRIMBERG

LIKE HIS ANCESTORS, *Sune Møller Petersen (above) and a team of Danish workers build ships by cutting planks with axes and making rope from horsehair and bast fiber. Light, maneuverable, and powered by sail and oars, such vessels sped the great Viking expansion. Warships were built serpent thin and flexible enough to bend with the waves. Cargo ships similar to the replica* Sif Ege *(below) had bulbous hulls—space for a healthy share of goods for each crew member.*



VIKINGS

the horizontal. Suddenly it's clear why generations of Norwegians have found release—and relief—on the broad, open sea. The first Vikings burst from such fjords and other northern European harbors with freewheeling pagan vigor, launching an age of exploration, commerce, and colonization that lasted almost 300 years, from about 790 to 1066. They were sea raiders and adventurers from three Scandinavian homelands—Norway, Sweden, and Denmark—and each group made its own bold sweep across the known and unknown world. The Danes made their mark in the British Isles and along the coastlines of Europe. The Swedes penetrated the continent on Russian rivers, reaching Constantinople and the Orient. The Norwegians struck boldly across the Atlantic to gain a foothold in America.



At the dawn of the ninth century Scandinavia was inhabited by autonomous tribes who spoke Norse, a Germanic language, and worshiped fallible deities like Thor, god of thunder. A few of their kings claimed loyalties beyond their own harbors, but each tribe was its own xenophobic universe, wrapped in a warrior code. Their theology lacked absolute concepts of good or evil; honor and battlefield valor were its highest virtues. Lusty maidens called Valkyries swept dead heroes to Valhalla.

The Norsemen fished, farmed, and bred cattle, but a shortage of arable land limited prosperity. The strong gained wealth in seasonal raids along nearby coastlines; pillage was a way of life, free of moral qualms.

Central Europe lay divided and vulnerable after centuries of tribal migrations that followed the collapse of the Roman Empire. Trade had expanded north from the Mediterranean, leaving wealth exposed in coastal towns. Scandinavian chieftains, or jarls, saw easy money and recruited broad-shouldered farmers' sons to man their sleek sailing ships. *Víking* is Norse for "piracy." The Norsemen went a-viking (map, pages 12-13).

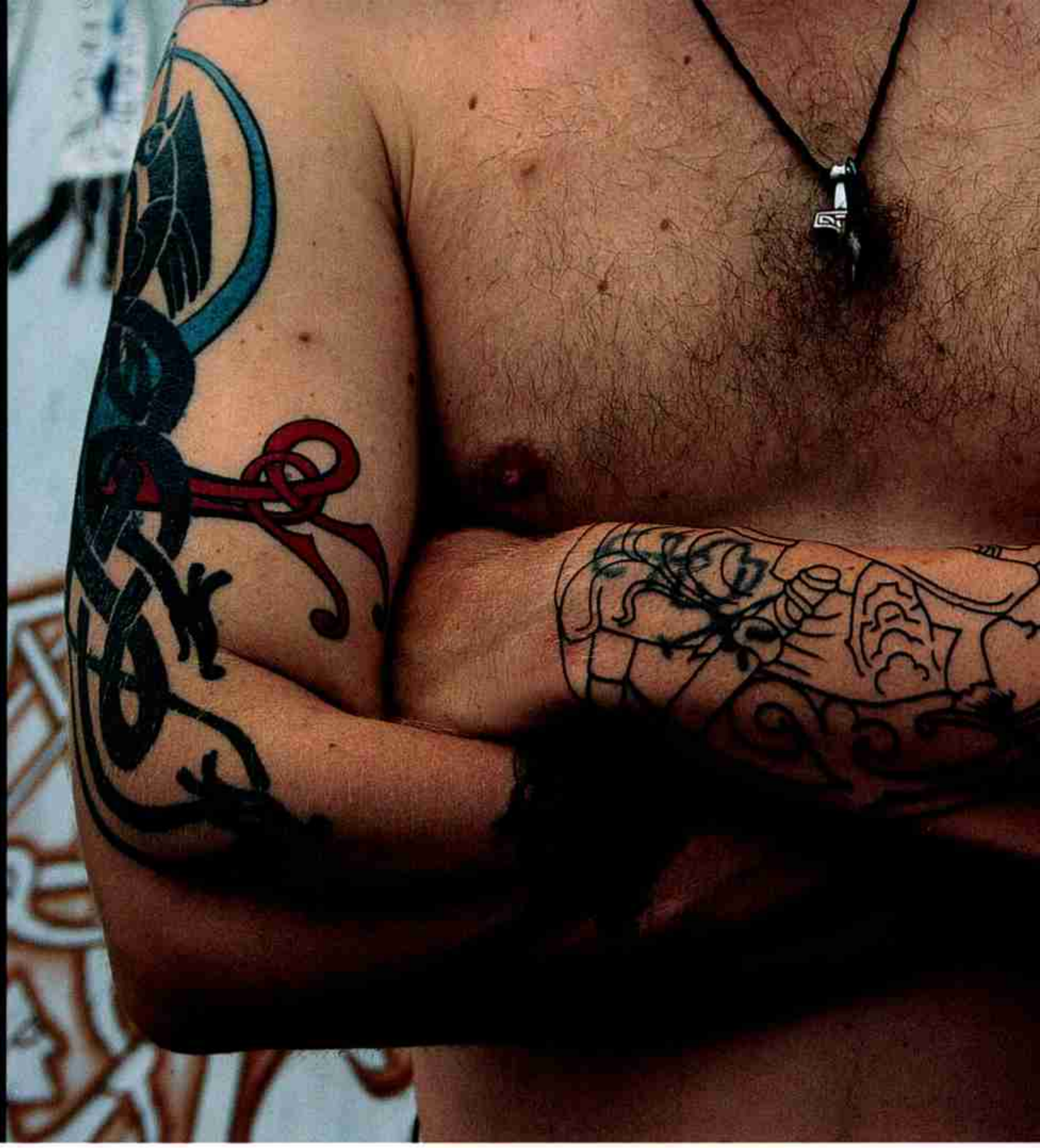
Some admirers have suggested that the Vikings were socially enlightened because their women were free to divorce and often held great power in the homelands when the men were abroad. But the Vikings held slaves and exalted bloodlust. Their more compelling appeal was that they were seen as free men acting on their own authority. One story relates that when the prince of the Franks sent an envoy to accost the chief of Viking marauders approaching Paris, the envoy returned perplexed. "I found no one to talk with," he explained. "They said they were all chiefs."

But competition for power among Vikings turned bloody when tribes began to consolidate and rival chieftains were often forced into exile. To recover their honor they gathered their followers and took to the sea in search of revenge and booty. The restless Viking spirit waned only at the turn of the first millennium, as the Norsemen grudgingly accepted Christianity and the centralized power of kings.

Over time the Vikings have been lionized by Scandinavians and demonized by others. They have been misused by Aryan supremacists and caricatured by football teams and motorcycle gangs. The horned helmet, even though Vikings never wore such horns, remains an instantly recognizable, often oafish, cultural icon.

Former staff photographer SISSE BRIMBERG, a native of Denmark, covered Catherine the Great for the September 1998 GEOGRAPHIC.

PICTURE STONE (ABOVE), 16 INCHES WIDE, HISTORICAL MUSEUM OF GOTLAND, VISBY, SWEDEN



"I LIKE BEING A VIKING," *says Jørn Olesen of Århus, Denmark. His arm is tattooed with the dragon slayer Sigurd; Thor's hammer hangs on his chest. He belongs to a Viking fighting club that puts on a show every year near town (far right). They fight like their heroes—in small bands. "Vikings didn't have manners in war," says Olesen. "They screamed, didn't stay in a straight line, and carried big axes."*

IN A CASUALLY BRUTAL AGE VIKINGS WERE

Christian monks depicted Vikings in apocalyptic terms. The Icelandic sagas and poems about the Viking age were written down centuries later. The Vikings themselves left no literature, only stones inscribed in the runic alphabet with terse declarations: "Bjorn Finnvid's son had this rock carved in memory of his brother Olaf. He was treacherously killed on Finnveden. God help his soul."

As I searched for the Viking legacy in 14 nations, I found myself chasing mostly ghosts, finding them in the dip of an oar, an attitude, the smell of dried fish and ship's tar, the whisper of waves.

Yet the past 30 years have been a time of new Viking discoveries. Archaeologists have revised dates using precise tree-ring chronology, located urban artifacts with metal detectors, found ships, and exposed intimate details of the Vikings' daily lives, down to the oatmeal gruel they ate. Many scholars now claim that Vikings actually enriched, rather than eroded, established European civilizations. In a casually brutal age Vikings were simply better brutes; they raided monasteries because that was where the money was. But the Norsemen were also astute merchants and politicians who expanded European horizons. They were craftsmen, shoemakers, blacksmiths, poets, and aesthetes who designed ships of noble proportions.

AN UNSPARING WIND energizes Denmark. It shifts the sand along the shoreline of the nation's northern tip, so that the land actually moves like the slow flicker of a candle. I felt it in Roskilde harbor when the wind first surged into the square sail of our



SIMPLY BETTER BRUTES.

replica Viking ship, tightening sheets and sending a shiver of creaks through the hull.

She was built the traditional way, with overlapped oak planking no thicker than a finger, and bound with iron rivets. Her sail was made of wool, and she wriggled through the water like an eel, flexing at the bow with every wave, recoiling in the stern, pirouetting on the ballast stones and single mast.

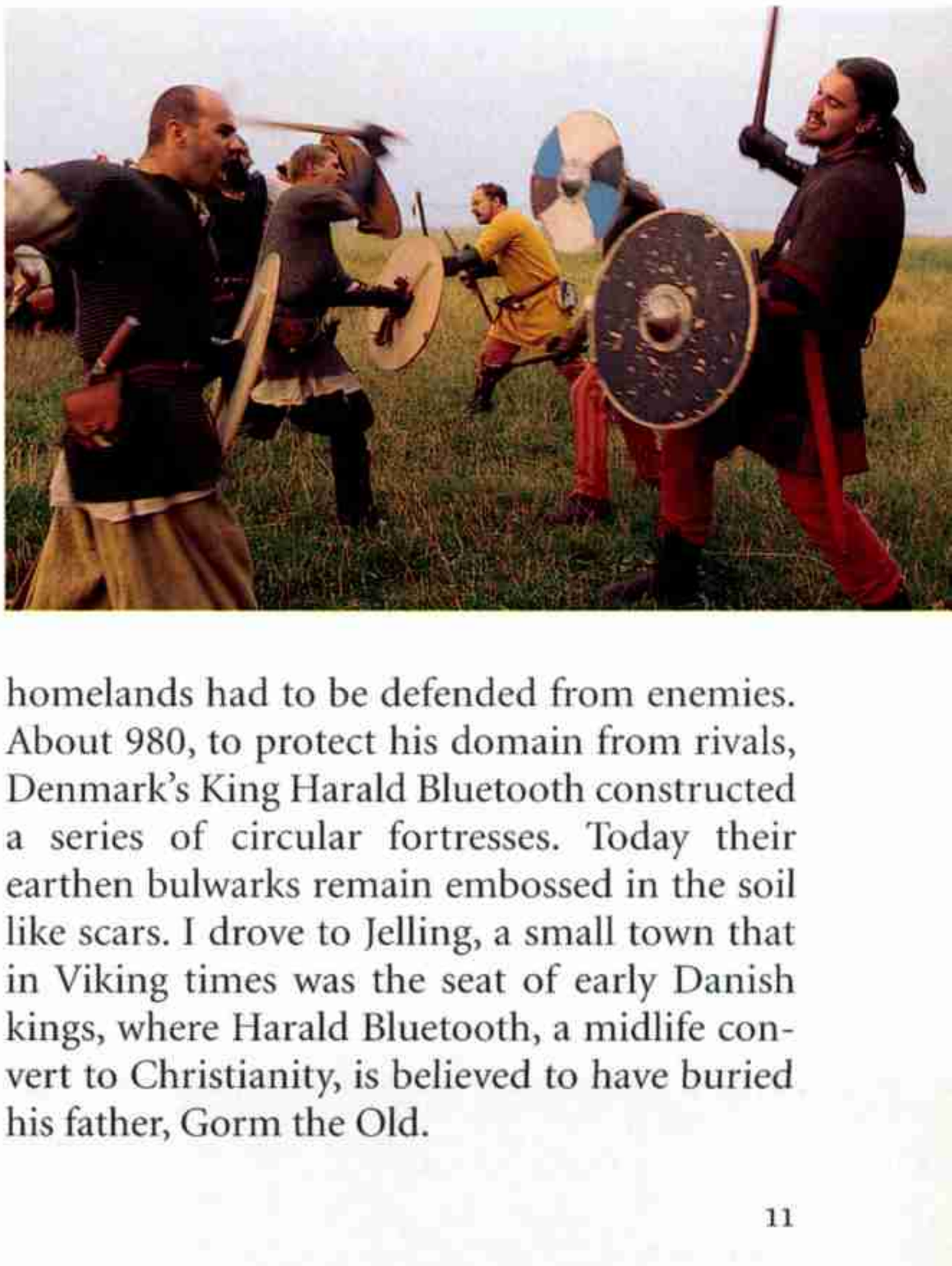
Beside me in the stern sat Ole Crumlin-Pedersen, a naval architect and Denmark's premier excavator of old ships. "A modern yacht is stiff—it will bang on the waves," he said, "but a Viking ship glides through the waves because the energy of the waves is absorbed in her structure. She's so well balanced you can steer her with your little finger. She's so beautiful you can keep her in your living room."

Scandinavians developed rowboats for centuries in Baltic waters, said Crumlin-Pedersen, "but it was the sail that made the Viking expansion possible." With sails the shallow-drafted Viking longships could sail at more than ten knots and appear like sorcery on a faraway coast. With all oars pulling, they could attack with the swiftness of a barracuda, penetrate any river valley. They could invade any beach, and they were light enough to be hauled overland on log rollers.

The finest Viking longships were also status symbols. Proud captains kept them fine-tuned, like Ferraris, and capped their swanlike prows with the carved heads of dragons and raptors, a merciless combination of elegance and terror.

When Danish archaeologists unearthed remains of five Viking ships in the 1960s near the village of Skuldelev, the Viking Ship Museum in nearby Roskilde was built to house them. Thirty-five years later workers dredging for a museum expansion found nine more ships. It was as if the Louvre had decided to build a new wing and found Monets buried next door. One remnant came from the longest Viking warship ever found—118 feet long and dagger thin, capable of carrying a hundred warriors.

But Viking warfare was not all offensive—homelands had to be defended from enemies. About 980, to protect his domain from rivals, Denmark's King Harald Bluetooth constructed a series of circular fortresses. Today their earthen bulwarks remain embossed in the soil like scars. I drove to Jelling, a small town that in Viking times was the seat of early Danish kings, where Harald Bluetooth, a midlife convert to Christianity, is believed to have buried his father, Gorm the Old.



GREENLAND

Baffin Island
(Helluland)

ca 1000

(Western
Settlement)

ca 985

ICELAND

Reykjavík
Thingvellir
Vestmannaeyjar

Brattahlid
(Eastern
Settlement)

NORTH AMERICA

Labrador
(Markland)

L'Anse aux Meadows

Newfoundland

(Vinland)

New
York

Cape
Cod

Nova Scotia

Gulf
of
St. Lawrence

Atlantic
Ocean

Viking Routes

- Earliest
- Erik the Red
- Leif Eriksson
- Ingvar
- Trading
- Ocean current

Historical names in parentheses

0 mi 600
0 km 600

NG MAPS
ART BY LASZLO KUBINYI

PATH OF THE VIKINGS

Their sphere of influence spread across Europe, to Asia, and to America in about 200 years. What drove the Norsemen remains uncertain. The vanquished blamed naked barbarism. Some historians cite a shortage of fertile land in Scandinavia and a desire to be free of powerful kings at home; others believe Vikings may have been opportunists in a time of political instability and growing international markets.

Svalbard
Spitsbergen
Lofoten
FINLAND
Lake Ladoga
St. Petersburg
RUSSIA
Volga
Bulgar
Staraya Ladoga (Aldeigjuborg)
Velikiy Novgorod (Novgorod)
Volga
Aral Sea
Samarqand
(Chorezm)
ASIA
SWEDEN
Neva River
Volkhov
Trondheim
Uppsala
Sigtuna
Mälaren
ESTONIA
Saaremaa
LATVIA
Riga
Volgograd
(Itil)
Caspian Sea
Gorgan
Sogne Fjord
ca 860
NORWAY
Faroe Is.
ca 800
Shetland Is.
ca 800
Orkney Is.
793
Oslo
Bergen
Rebild
(Birka)
Baltic
Stockholm
Visby
Gotland Sea
Arhus
Skuldelev
Jutland
Copenhagen
DENMARK
Jelling
Roskilde
Wolin
POLAND
Dnieper
Kiev
UKRAINE
(Berezany)
ca 1041
Black Sea
North Sea
Hebrides
SCOTLAND
Holy I. (Lindisfarne)
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EUROPE
GERMANY
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IRELAND
WALES
ENGLAND
Dublin
London
(Quentovic)
Cork
Limerick
Rouen
English Channel
Paris
Orléans
Normandy
Nantes
FRANCE
Bordeaux
ITALY
Rome
GREECE
ARABIA
SPAIN
Mediterranean Sea
Strait of Gibraltar
AFRICA

Gnawed by a dragon, the roots of the great tree Yggdrasill (far left) connected the nine worlds of Viking myth. Humans lived in Midgard, where the gods made land, water, and heavens from a slain giant's body, and where day and night raced chariots across the sky (top) as wolves chased the sun and moon.



HEAVY METAL: *Earthmoving equipment uncovered ten pounds of tenth-century silver at a construction site in Rebild, Denmark, in 1971. Hoards of Viking-age silver are dug up in every part of Scandinavia. Coins and metal jewelry that Vikings acquired abroad by trade or force were often melted into ingots and twisted into armbands of standard weights, then cut into pieces for everyday transactions. The hoards may have been sacrifices to the gods or stashed personal fortunes left unclaimed.*

"Here is the first evidence of a Scandinavian king handing power on to his son," said Karen Boe, a historian from Denmark's Silkeborg Museum. The concept took root: The present monarch of Denmark, Queen Margrethe II, can trace her lineage back to Gorm.

The Danish landscape, with its neat, buttery farmland, does little to recall days of Viking vigor. And yet there is the wind. By the time Boe and I reached the beach on the tip of Jutland it had turned wicked, flattening the Queen Anne's lace that billowed along the roadsides.

Boe, a tall, ponytailed Dane who was once a professional sailmaker, clearly gloried in the gale. "I think the Viking age came because of a dynamic of the society," she said, "a certain energy that makes people go out and look for other things. Can you imagine being here and not wanting to go?"

As much of Europe wrung its hands, Vikings sailed from Denmark to pillage with near



NATIONAL MUSEUM OF DENMARK

impunity. They knifed up rivers, deflating fat trade depots like Dorestad on the Rhine. They attacked Rouen, Nantes, and Paris. They rounded Gibraltar and harried Spain. Tradition has it that one raiding party enthusiastically ransacked the wrong Italian city, thinking it was Rome. In 911 Charles the Simple, King of France, ceded Normandy to a Viking chieftain named Rollo, who promised to protect the coast against more avaricious Norsemen.

Norwegian and Danish Vikings colonized the Orkneys, Shetlands, and Hebrides. They harassed Wales and occupied the Isle of Man, which for 300 years thereafter was a staging area for Viking raiding parties.

Ireland already festered with belligerent Celtic chieftains and dozens of armies, so the Vikings never settled the interior, but they made the island a trading base. They controlled the ports of Limerick and Cork, and their fortified sea base and slave entrepôt on the River Liffey became the city of Dublin.

"The Irish and the Vikings are very intermixed cultures," said Eamonn Kelly, an archaeologist at the National Museum of Ireland in Dublin. "The old view that the Vikings were thugs and enemies of Christ is still around, but increasingly they're seen as making positive contributions to Ireland."

The Vikings plainly brutalized England's green and docile east coast on June 8, 793, when they arrived to storm the monastery of Lindisfarne. Many historians regard the event as the opening salvo of the Viking age, and one that shook England to the heart. "Never before has such terror appeared in Britain as we have now suffered from a pagan race," lamented a cleric at the time.

I drove to Lindisfarne on a warm February day, between hedgerows and the dark branches of oaks that shook out flocks of starlings. It lies south of the Scottish border, on Holy Island, and is accessible by land only at low tide. Standing on the beach, I could almost see the dragon ships sweeping in. There would have been the quiet rasp of gravel, the clink of weapons, the heavy breath of men. Perhaps only the bleat of a goat gave warning.

In 865, relates the Anglo-Saxon Chronicle, "a great heathen army" landed in East Anglia, soon to settle. They commandeered the city of York, which they called Jorvik. Under almost a hundred years of Viking rule, York prospered and grew as a center of international trade. There the Vikings became urbanites. They laid out city streets, minted silver coins, and mass-produced the necessities of life—combs from deer antlers, leather shoes.

The Vikings conquered three of England's four kingdoms; only Wessex, in the south, escaped. By the tenth century nearly half of England lay under Viking dominion, an area called the Danelaw that extended to the border of Scotland.

In the 1970s the York Archaeological Trust dug through 20 feet of spongy deposits to reach the Viking city and found delicious details of everyday life—knives that could be sharpened and used, ice skates made of bones,

clothing, even the flies that had buzzed around a hot cobbler's workshop in summer.

"Despite the Vikings' savage reputation, there's not a single sword," said Richard Kemp, archaeologist in charge of the Jorvik Viking Centre. "The artifacts reveal people making a living, weaving, gathered around fires telling stories. But let's not run away with the idea. He wasn't called Erik Bloodaxe because he was good with the children."

Bloodaxe was the last Viking king of York, deposed in 954, but soon armies of Scandinavian extortionists invaded to demand *danegeld*, protection money, from weak English rulers. Vikings actually held the English throne for decades. In 1066, when Harold II was crowned, two Viking descendants waited in the wings: the ruthless King Harald Hardrada of Norway and William of Normandy, descended from Rollo. Their attacks came days apart.

In one of history's pivotal junctures, the English army beat back the forces of Harald Hardrada at the Battle of Stamford Bridge near York but then had to quickly about-face and confront the Normans who had meanwhile streamed across the Channel. In what many consider the closing act of the Viking age, the English were overrun.



HISTORICAL MUSEUM OF GOTLAND

A CONSUMING FIRE energizes Sweden. As Vikings, the Swedes believed their world—and all that was in it—should end in flame. They placed their honored dead in grounded ships, along with tools and weapons, and set the ships ablaze; the souls would wing to the halls of Asgard, some to Valhalla, for an eternity of feasting and brawling.



IT WAS THE SAIL THAT

Viking-age Swedes were predominantly a people called Svear, who gave modern Sweden its name—Sverige. They lived in Uppsala, north of Stockholm, and by Mälaren lake, and they gathered wealth through trade with southern and eastern Europe, even with Asia.

A whiff of paganism lingers in Uppsala, where the Svear appeased the gods by sacrificing animals and human beings in sacred groves. As I walked along their burial mounds with Swedish friends Mattias and Monika Klum, dark jackdaws circled above the graves as if sensing carrion, and Mattias spoke of local people who still gather here on auspicious nights to build bonfires. Some, it is said, tap into the old primal energies.

The Svear established Sweden's earliest towns—Birka, Sigtuna—and on the Swedish island of Gotland, where Vikings made supply



WOOLEN SAILS *for replica ships start with the roundup on Jens Jakobsøy island of free-range sheep belonging to an ancient Norwegian breed. Per Johnson and his family pull the wool by hand—strong outer hair for the warp and downy inner wool for the weft. Tar and fat are added to the woven fabric to create water-resistant, wind-tight square sails like those carved on Viking picture stones (far left).*

MADE THE VIKING EXPANSION POSSIBLE.

—DANISH NAVAL ARCHITECT OLE CRUMLIN-PEDERSEN

stops, a prosperous merchant class emerged. Archaeologists in Gotland have unearthed 100,000 silver coins—from Samarqand, from Baghdad.

For centuries Swedish raiders pillaged along the Baltic's eastern shores, but there they faced rivals such as the Kurs and the piratical Saarlased, or Oeselians, from the Estonian island of Saaremaa. Saaremaa's current coat of arms pictures a longboat, and Viking images thrive in Latvian and Estonian legends, jewelry, and folk dress.

"Saarlased were the Vikings of the Baltics," said Bruno Pao, a marine historian on Saaremaa. "We have found stone ship settings, burial mounds, silver hoards. The pagan era here lasted until the 13th century."

Customs still mirror pre-Christian ways. Souls soar to the afterlife through the smoke of burning boats. In Estonian myth they ascend to the Milky Way, known as the path of the waterbird, the *vesilind*.

Midsummer night was brisk and rainy when I arrived on Saaremaa, but the people of Kihelkonna village built a bonfire anyway, placing an old fishing boat on the pyre. Soon the ribs of the old boat appeared like a skeleton in the roaring heat. In the gloom of the white night the villagers drank beer and danced as ashes and smoke rose toward the stars and their infinity of souls.

Past the Baltic, Swedish Vikings advanced along continental rivers, peppering an area twice the size of Alaska with trading settlements. By the early ninth century they were navigating the Volga and the Dnieper to reach the merchants of the Abbasid caliphate. By 860 they had attacked Constantinople, where their

ferocity was so celebrated that Byzantine emperors later hired Swedish strongmen to serve in a unit known as the Varangian Guard.



The Vikings' eastern road often began at the swampy mouth of the Neva, site of today's St. Petersburg. Viking merchants sailed their ships to Lake Ladoga and up the Volkhov to Aldeigjuborg, gateway to Russia, now the town of Staraya Ladoga. The Slavs and Finns there called them Rus, after the Finnic term for Swedes, Ruotsi.

Once the boomtown of a new empire, Staraya Ladoga lay sad and dreamy when I arrived. A whisk broom of rain swept the Volkhov, where men fished silently in wooden rowboats. With Nadia Milutenko, a young historian whose deadpan academic face tended to erupt in luminous smiles, I visited some of the Viking burial mounds that edge the river.

"The Vikings didn't have a fatherland to die for," she said, putting things in a Russian perspective, "just one king or another. They came as traders, not conquerors. And very soon they became a part of the people who lived here."

By one old account the first wave of Vikings was driven out of northern Russia, but chaos followed, and other Scandinavians were invited in to restore order. Thus Prince Rurik and other Viking aristocrats established power bases in Russia. These Rus eventually founded the first Russian state—centered on Kiev, in today's Ukraine—and gave their name to Russia, a cultural inconvenience that Soviet historians were compelled to dispute for decades.

Today many Russians feel nostalgic for the Viking age. "We want to know about our heroic past," said Milutenko. "Through the Vikings we can see ourselves as part of the great European process."



SILVER PENDANT (TOP), ACTUAL SIZE, STATE HERMITAGE MUSEUM, ST. PETERSBURG

VIKING HEIRS? *Children in Velikiy Novgorod (above), an early Russian capital said to have been founded by Scandinavians, may be descendants of Norse traders who rowed up eastern Europe's rivers in search of glory and Arab silver. A few Vikings—locals called them Rus—continued to Constantinople and Baghdad. Many stayed in Russia and adopted Slavic ways. Back home in Sweden, families honored those who died in distant lands. Varin dedicated the Rök Stone, right, to his son Vaemod.*



But the Byzantine Empire and its Eastern Orthodoxy influenced Russia far more than the Vikings did. A Kievan Rus prince, Vladimir, converted to the new faith in 988 and adopted it for his subjects, not only opening Russia to the civilizing forces of the Mediterranean but also ensuring that it developed a culture separate from most of Europe, which had been swept by Roman Catholicism. Thus was a breach created between East and West.

ICE ENERGIZES the North Atlantic, gives it backbone and a common challenge. Ice glazed the fishing boats huddled at the pier in Reykjavík, Iceland's capital, where I waited one dark morning. A streetlight filtered snowflakes. Temperature, zero.

Óli and Thór, crewmen of the small cod-fishing boat named *Gunni,* arrived wearing sneakers. "A great day we're going to have, fine weather," said Óli, grinning sleepily. We set off through the choppy harbor as dawn broke. Terns teetered on the wind beside us.

For seven hours, as the sea spit froth and the boat heaved, Óli and Thór thrashed like warriors to extract the plump-bellied, 30-pound codfish from the trawl nets that spun to the icy deck. I could do no more than grip the handle of the cabin door, immobile and deathly sick.

Later I asked Óli what he did after work. "I take a shower and go run ten miles," he said. "I like to stay in shape."

Those who settled Iceland came mostly from Norway, a nation famous for rugged people such as polar explorers Fridtjof Nansen and Roald Amundsen. "Norwegians have used the Vikings in building a national identity," said Dagfinn Skre, an archaeologist at the University of Oslo. "Norway had an inferiority complex. We were part of Denmark until 1814 and part of the Swedish kingdom until 1905. But we could always look back and say, 'We were the tough guys.'"

The first tough guys to sail beyond the Scottish islands were seventh-century Irish monks in skin boats. The Norwegians who followed a century later—first to the Faroe Islands, then to Iceland—were mostly farmers, strictly speaking not even Vikings. Later came disaffected lesser jarls, reportedly fleeing King Harald Finehair, who had imposed central authority over Norway in 885. They all dreamed of a New World without such potentates.

Although it took courage to navigate the dank, iceberg-filled waters of the north without instruments, most of the uninhabited islands in the North Atlantic were discovered not by visionaries but by mariners blown off course. Once they learned the geography, they island-hopped: Norway to the Faroes took just a few days; another three or four led to Iceland.

Iceland's pioneers were free men and women, many with Celtic slaves. All were invested with the audacious notion that this rough volcanic island, still steaming from its genesis, could provide a better life. Guided by Norwegian traditions, they created an aristo-democracy ruled by 39 chieftain-priests called *godar,* who met each year in the national assembly, the Althing. The gatherings centered around a natural amphitheater called Thingvellir beside a jagged fissure on the diverging rift between the North American and Eurasian tectonic plates—where the Old World is literally separating from the New.

ICELAND REMAINS A COMMUNITY THAT

The Icelanders recognized no king and raised no army, and thus lacked an executive power. The aggrieved themselves were left to implement Althing decisions, even death sentences, a system that led to a cycle of revenge.

Iceland remains a community of pragmatists that does not suffer fools gladly, and its modern Scandinavian veneer barely hides a Viking heart. Iceland even recognizes its own pagan leader, a bearded man named Jörmundur Ingi, who heads a registered membership of only 400 but believes he represents many hundreds more.

"We maintain that the Viking mentality and old beliefs never left the Icelanders," he told me. "Some people believe that Christianity never did take hold here. It was like a patina on top of the culture."

Most educated Icelanders smile at this, call it nonsense, and yet road-repair crews, for example, may consult a medium to make sure

DOES NOT SUFFER FOOLS GLADLY.

HOT SPRINGS AND GEYSERS *must have puzzled Norse settlers when they came to Iceland about 870. They called the strange land's future capital Reykjavík, or "steamy bay." One optimist claimed butter dripped from the grass. The sea still provides work for Óli Andrésson (below, at right) and Thór Gudbjartsson, who fish for cod. Most Icelanders are direct descendants of the settlers—and their slaves.*





Iceland's democracy began in this rocky breach at Thingvellir when the Althing, ancestor of today's parliament, met in 930. Viking chieftain-priests gathered here to proclaim laws and settle disputes. "Icelanders have no other king than the laws," wrote an 11th-century German cleric.

their work won't disturb elves under the rocks.

Icelanders preserved the Norse language, although they did not put it into writing until the early 12th century. Christian scholars later compiled the oral history of the Viking age. Of these writings the Edda poems tell of gods and heroes, while skaldic verse is a mix of myth and flattery, often composed by *skalds*, court poets.

The sagas themselves are mostly heroic fiction, but much accurate history has been sifted from them. University courses and night classes in saga studies are filled in Iceland, and, in a countryside where nearly every mountain, stone, and farmhouse seems connected to the stories, "saga tours" are popular.

"Until this century," said Fridrik Haraldsson, a tour guide, "people believed in the sagas as they believed in the Bible."

Many sagas are written in terse prose about real people, like this Hemingwayesque excerpt from *Njals Saga:*

Kolskegg moved quickly and stepped towards him and struck him on the thigh with his short-sword and cut off his leg, and then he said, "Did that hit you or not?"

"This is what I get," said Kol, "for not shielding myself,"—and he stood for a while on his other leg and looked at the stump.

Kolskegg said, "You don't need to look: it's just as you think, the leg is gone."

Then Kol fell down dead.

BLOOD WAS ON THE HANDS of Erik Thorvaldsson, known as Raudi, the Red, when he and his father left Norway for Iceland around 965. And when the quarrelsome Erik had slain one too many enemies in Iceland, he was again banished from the protection of the law. Erik assembled ships and followers and cast off into the western sea, a brazen act based only on tales of an unknown shoreline sighted by a windblown mariner decades earlier.

Erik found land and stayed for three years exploring treeless fjords. He returned to Iceland with tales of a fertile "greenland," hoping to entice others to go back with him. In 985, 25 ships sailed west from Iceland, carrying settlers with their livestock. Only 14 arrived; the others turned back or perished.

Colonizing Greenland did not halt the Viking momentum; hunting parties traded with Inuit in Labrador and on Baffin Island. And there was no end of land to discover. Bjarni Herjolfsson, another Icelander blown past his destination, sighted a flat shoreline covered with woods far to the west. He was carrying merchandise and did not stop, so the weight of history fell on Erik the Red's son, Leif the Lucky. Backtracking Bjarni's voyage about 1000, Leif led the first Europeans to set foot on this new land.

Two short, colorful, and in part fanciful sagas, *The Saga of the Greenlanders* and *The Saga of Erik the Red,* outline the grand adventures of the clan, but they have long teased historians with vague directions and contradictory details. They relate that Leif wintered in a place he called Vinland, where he found grapes, salmon streams, and pastures, then returned to Greenland in the spring.

Leif's brother Thorvald, excited by the stories, launched his own journey years later. He was the first European to encounter Native Americans, whom the Norse called Skraelings, and the first to die at their hands, shot with an arrow. Thorvald's last words: "We have won a fine and fruitful country, but will hardly be allowed to enjoy it."

GUDRID EPITOMIZED

Two years passed before an Icelandic merchant, Thorfinn Karlsefni, married a widowed daughter-in-law of Erik's, Gudrid Thorbjarnardottir, and left with three stout ships in a serious attempt to colonize Vinland.

They traded and battled with the Skraelings and bickered over women (there were not enough). One summer they camped on a bay rich in fish, a land with self-seeded wheat and rolling pastures that knew no winter frost, a place they called Hop. Gudrid gave birth to a boy named Snorri, the first European born in America, but after three winters they withdrew to Greenland, then to Iceland.

Gudrid became an almost mythical figure who epitomized the vigor and independence of Viking women. When her children were grown and Thorfinn had died, she made a pilgrimage to Europe, in an age when women traveled little. She died a nun, at Snorri's farm in Iceland.

No one really knows how to match saga details to today's geography, but the tales

THE INDEPENDENCE OF VIKING WOMEN.

ICELANDIC HEROINE *Gudrid comes to life in a play by Brynja Benediktsdóttir. Actress Tristan Gribbin portrays the explorer, mother of the first European born in America, who later became a Christian pilgrim and a nun. True wisdom, said a Viking poet, comes to one who "has traveled far and knows the ways of the world." The rich took horses on voyages, even into the afterlife: Horses were often buried with their owners.*





KEEPER OF THE FAITH *Jörmundur Ingi, leader of Iceland's pagans, stands in their Reykjavík burial ground. The old religion faded as the Vikings adopted Christianity. But change came slowly. Some became not-so-peaceful missionaries, seeking converts by the sword. Viking times are ancient history, yet something, Jörmundur thinks, lives on. "Cattle die, kindred die, every man is mortal," states an Icelandic poem. "One thing that never dies: the glory of the great deed."*

suggest that Vinland must have been around the Gulf of St. Lawrence—then the northern limit of wild grapes and the southern limit of Atlantic salmon. And Karlsefni's settlement of Hop?

"New York Harbor," said Páll Bergthórsson, an Icelandic meteorologist who has retraced the Greenlanders' routes. "Everything matches with the saga description."

But the only clear evidence of Norsemen west of Greenland was found in 1960 on the northern tip of the island of Newfoundland, at L'Anse aux Meadows, by Helge Ingstad, a Norwegian adventurer and writer, and his wife, Anne Stine, an archaeologist. For years the academic community was split over whether their finds were legitimate.

I talked to Ingstad, now a gracious and keen-minded widower of 100, at his home on an Oslo hillside. "Nobody can be a skeptic anymore," he said. "Even UNESCO has accepted L'Anse aux Meadows as one of the most important historical monuments."



WOODEN CROSS (BELOW), 10 INCHES LONG, NATIONAL MUSEUM OF DENMARK

Yet some controversy remains. Although most linguists believe that Leif's Vinland was named for grapes, Ingstad believes the old Norse word *vin* signifies meadowland. Grapes and wine, he said, were merely embellishments added later.

"L'Anse is unique in Viking culture," said Wallace. "It's not a settlement; it's a base for exploration, a gateway to Vinland. Vinland includes all the shores around the Gulf of St. Lawrence."

So Vinland might best be imagined as a body of water, rather than a body of land. Wallace believes Viking explorers and supply expeditions must have circled the bay, moving quickly from subarctic climate to forest canopy, finding wild grapes, lumber, and butternuts on the north coast of Nova Scotia.

They kept their base on the bleak promontory at L'Anse aux Meadows because there were no Skraelings, and it was a control point for access to the rest of Vinland. L'Anse aux Meadows, Wallace concludes, was Leifsbudir, Leif's camp, where many Greenlanders wintered.

Strung out on the frayed tip of the westward expansion, the North American colonies lasted only decades at most. The distances back home were too great, the populations too small, the natives too belligerent. Unlike the Spanish and Portuguese, who brought gunpowder to the New World, the Vikings had no arms advantage over the Indians; they fought bows and arrows with spears and battle-axes.

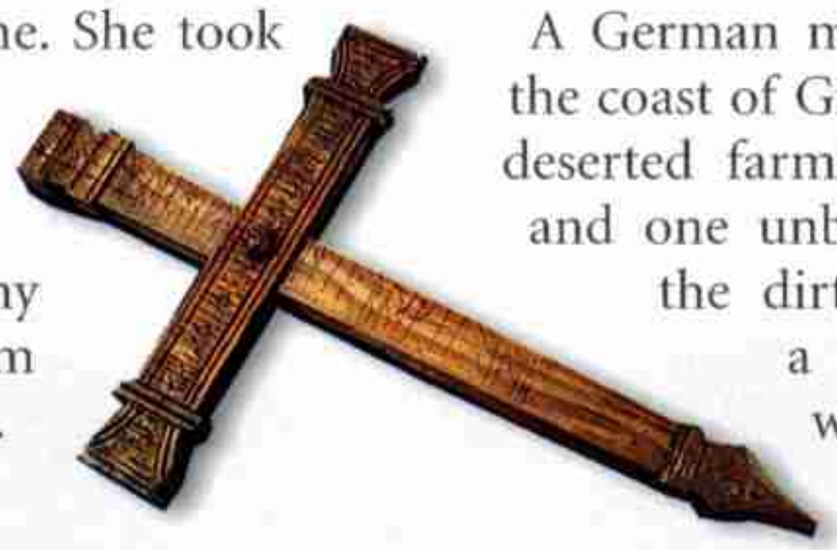
Across the ocean, as the Middle Ages ended, the Scandinavian homelands became Christian nation-states. The vigorous notion of individual freedom, a subversion that Vikings energetically flaunted among subservient populations, became an outlaw creed.

But the colony of Greenland, some 2,500 people at its peak, survived for 200 years more as a Viking society. In the 1990s an international team of archaeologists dug through permafrost to excavate a complex of interconnected buildings that once was part of the so-called Western Settlement. They unearthed kitchen utensils, locks, keys, tools, and wooden bowls.

The colony faltered when the climate deteriorated. The Greenland ice cap slouched coastward, blotting out green valleys; pack ice suffocated the fjords. Trade and European contacts dwindled.

A German merchant ship that reached the coast of Greenland about 1540 found deserted farmhouses, empty fish sheds, and one unburied man, face down in the dirt, dressed in sealskin and a woolen hood, a bent and worn knife by his side. □

ONE CHILL MAY DAY in Newfoundland I met Birgitta Wallace, a Swedish archaeologist for Parks Canada, who had worked with Ingstad and Stine. She took me to the site on Epaves Bay where they had excavated three groups of turf houses and the remains of a small smithy where nails were made from bog iron a thousand years ago.





BY MICHAEL KLESIUS
NATIONAL GEOGRAPHIC STAFF
PHOTOGRAPHS BY SISSE BRIMBERG

MYSTERY SHIPS FROM A DANISH BOG

ABOUT THE YEAR A.D. 350, during the Iron Age in northern Europe, a ship carrying 40 or so warriors came ashore on a beach in what is now southern Denmark. With its open hull, overlapping planks, herringbone array of oars, and tall, matching bow and stern, the oak vessel embodied a classic Scandinavian form. The bearded warriors carried iron swords and wore woolen clothing. A modern observer might have guessed they were Vikings—but the rampages of the Vikings would not begin for another 450 years.

The swing of an ax helps sink an enemy ship in Iron Age Denmark. Dragged inland to a sacred lake, the vessel was probably scuttled with its valuables to thank the gods for success in war. Its recovery is shedding light on pre-Viking ship design.

ART BY GREG HARLIN; SILVER-AND-GOLD LION (TOP), TWO INCHES LONG, NATIONAL MUSEUM OF DENMARK, COPENHAGEN

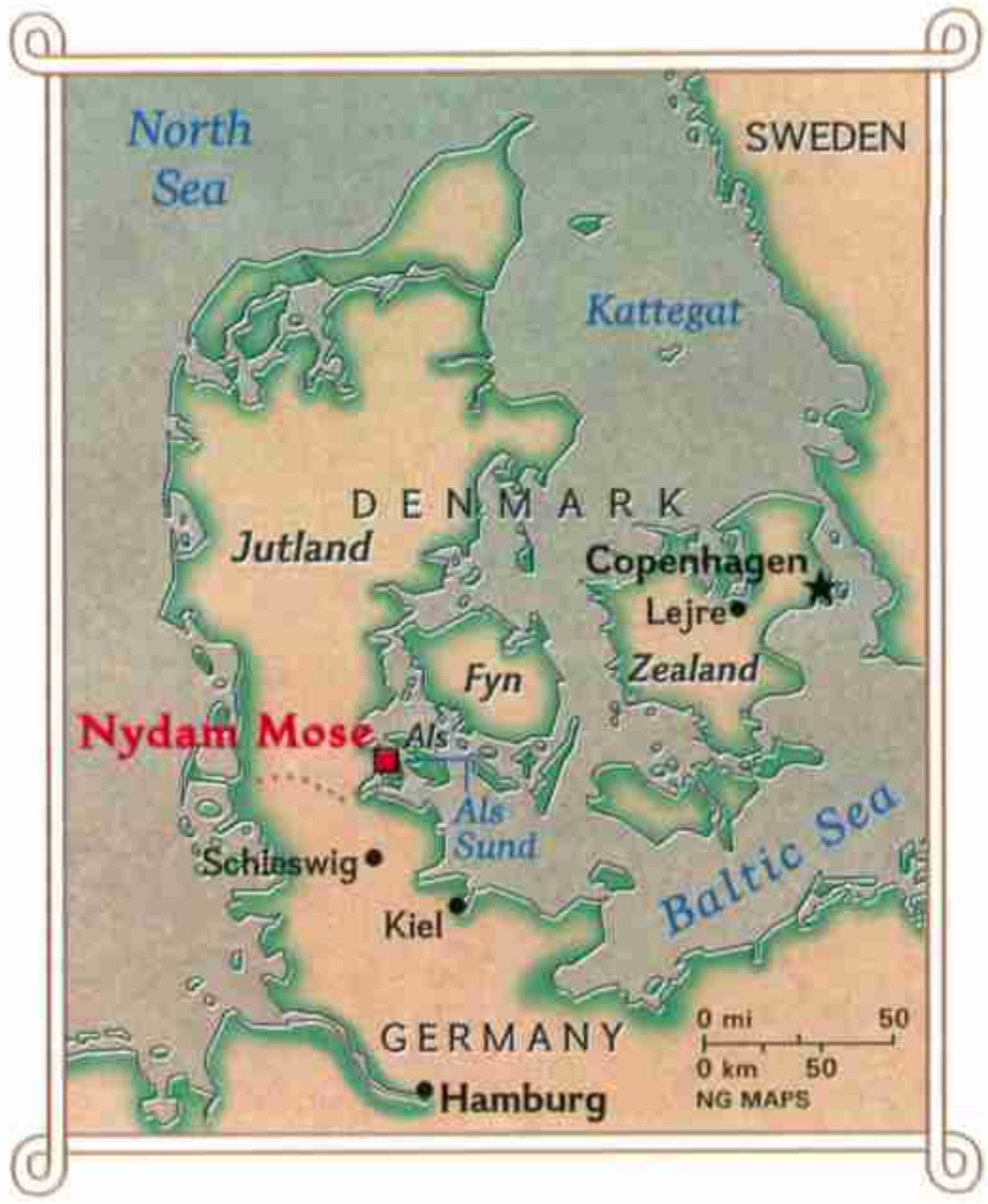
Instead these men were prototypes of the Vikings, according to archaeologists who have been quietly excavating this ship and two others like it from a Danish bog called Nydam Mose. The ships and weapons, which were thrown into a freshwater lake that covered the site back then, are not only shedding light on the origins of Viking traditions but also illuminating the darkness of Iron Age history in northern Europe. As archaeologists recover more artifacts, they can better grapple with fundamental questions: How and why did coastal ships end up in a lake two miles inland in the first place? How did people live during that time? Was life more violent than today?

To answer these questions, archaeologists offer a hypothetical scenario in which the fortunes of the warriors turned against them that day long ago. When their ship's keel bit into the sand, the warriors hopped over the gunwales into the icy water. As a numbing rain slanted out of a bone-colored sky, they dragged their five-ton ship onto the beach, then marched into the woods, and after a time came upon a village near a lake. A dozen thatch-roofed longhouses sheltered families with their livestock. Smokehouses, a blacksmith's forge, and other small buildings filled out the settlement.

When the warriors attacked, young men scrambled outside, ready for the fight. The intruders, outnumbered, soon perished at the hands of the locals.

The victors trudged off in the direction their attackers had come from and eventually found the empty ship. The next day they rigged horses to the vessel and hauled it inland to the lake. Once there, the men set about smashing belongings collected from the bodies of the warriors: swords, lances, axes, and personal effects like coins, lockets, even tweezers and fingernail cleaners. The villagers fractured wooden spears and ax handles, splintered arrow shafts, and bent the arrowheads. The blacksmith took the swords, each as valuable as a horse, bent them into tortured shapes, and hurled them into the lake. The villagers believed that sacrificing such treasures would express gratitude for their victory to the gods believed to inhabit the lake.

Someone hacked open the hull. As water gushed in, the villagers nudged the ship away from the bank and chanted prayers to the gods of the tribe. They slaughtered some horses and threw them into the water. Then they watched the ship heel over and slip beneath the surface.



"LAKES WERE THE CHURCHES of the Iron Age," said Peter Vang Petersen of the National Museum of Denmark. "They were sacred places."

How sacred remains a mystery: Did people visit certain lakes frequently to pray, or did they come only on special occasions? The valuables deposited in lakes in Denmark, as well as in Germany and England, suggest deeply held religious beliefs and may be the basis for myths like King Arthur's sword Excalibur. Petersen and others think these lakes served for centuries as places to offer up weapons won in regional conflicts. Almost seventeen centuries after the demise of the Nydam ships, I've set out on a search for the relics of that time, when security ended at the edge of one's village.

Each year archaeologists retrieve fragments of the ship sacrifices from Nydam, a swamp the size of a baseball diamond surrounded by pungent cow pastures and fields of wheat and rape. Vang Petersen, a wiry archaeologist with gray bristle-brush hair and a matching beard, stood in a chest-deep pit with mud walls black as tar. With filthy hands he gingerly removed the broken wood shaft of a lance.

"If you want to know what I think the real

SISSE BRIMBERG also covered Vikings for this issue.

mystery of Nydam is," he said in a thick Danish accent, "it's, What are the powers that make people destroy wealth in such amounts? These things we've found are very expensive. To an Iron Age man a sword cost as much as a modest car today. It was a sign of prestige."

For centuries silt oozed into the lake, blanketing the artifacts and shielding them from oxygen and bacteria. Much of the wood never decayed but became soggy, like biscuits dipped in tea. By the 1860s Nydam had become a *mose* (pronounced "mooze," the Danish word for "moor") firm enough to walk across. Farmers digging peat for fuel began to discover weapons, silver coins, and wooden planks. Conrad Engelhardt, a Danish archaeologist, soon excavated parts of three Iron Age ships: two oak and one pine. All three were likely deposited as ritual offerings to thank the gods for victory. Two ships were sunk intact; the third was chopped up and thrown in piecemeal.

After a war that broke out in 1864, the region including Nydam Mose became part of Prussia. In 1877 the larger oak ship—the only one that had been reconstructed—was moved to the town of Kiel, in Germany. Today it resides in the Archäologisches Landesmuseum in Schleswig.

I drove there and touched it, aware that the museum discourages this but invited by the lack of a barrier around the relic. The wood felt smooth as polished marble. Tannins from the Nydam silt had turned it shiny black. New metal braces held the hull together. It was 75 feet long, much larger than I had expected. The entire display rests on a rolling platform in a room larger than a basketball court.

"This ship was a warship," said Michael



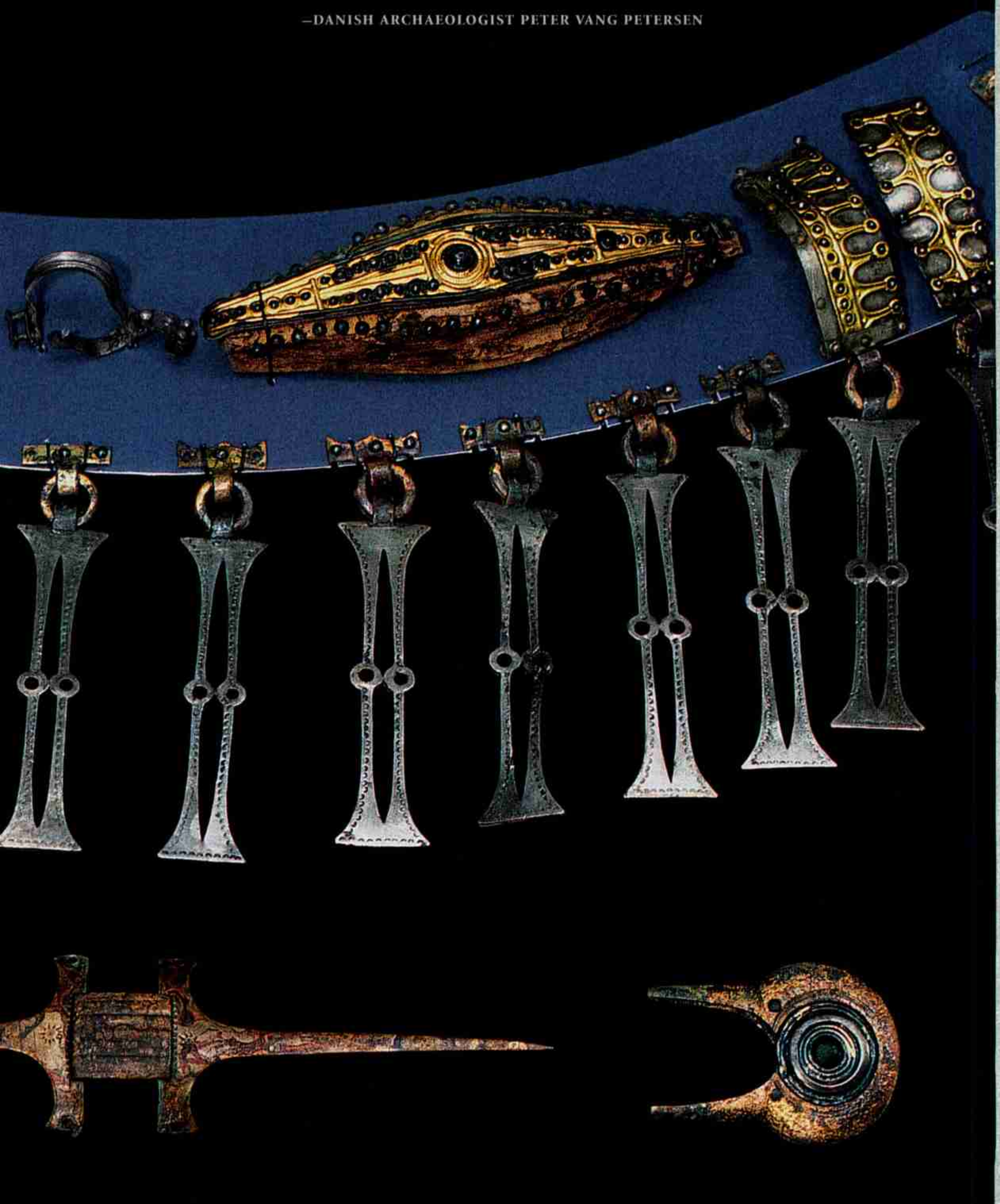
HEAD IN HAND, *archaeologist Erik Jørgensen frets as 1,650-year-old wooden lance shafts are carefully removed at Nydam Mose, discovery site of three Iron Age ships. The work must be done quickly—such artifacts begin to decompose when exposed to oxygen. "Because excavation methods improve all the time," says Jørgensen, "we'll leave other material here for future archaeologists."*

WHAT ARE THE

Intricate handiwork in silver, gold, and bronze, a belt (above) and scabbard ornaments (right) were exhumed from Nydam Mose. A runic inscription on the scabbard reads "harkilaR ahti," thought to mean "Harkilar owned." Archaeologists believe Harkilar was a commander of high rank who also owned the belt, his status announced by the jangle of precious metals.

POWERS that make people destroy wealth in such amounts? These things we've found are very expensive. To an Iron Age man a sword cost as much as a modest car today.

—DANISH ARCHAEOLOGIST PETER VANG PETERSEN



NATIONAL MUSEUM OF DENMARK

Gebühr, a German archaeologist, "but it may have done more damage to international relations since it was found than when it was going around burning villages and killing people."

Gebühr, a curly-haired, bearded professor from the University of Hamburg, was referring to the ongoing tension between Germans and Danes over rights to the ship. He didn't dwell on the ownership issue but instead talked about the instability of life in Iron Age Europe. He thinks such ships carried emigrants as well as warriors.

During the first and second centuries A.D., Gebühr believes, wealth and population grew steadily in this part of Germany. He has found that cemeteries encompassed increasing numbers of burials, with ever more valuable grave goods. Gold, iron, and other precious materials were acquired through trade with the Roman Empire.

But a climate-driven crisis ended that period of prosperity. A cold, wet spell lasting several decades created bogs and lakes and destroyed good farmland. Staple grains could not thrive. Meanwhile tribes to the south were overrunning the Romans and disrupting trade.

"There's evidence that people were leaving this region, Schleswig-Holstein, after A.D. 320, and they might have been going to England in ships like this in the hope of finding more land," says Gebühr.

Scarcity may also have increased conflict among local groups, including raiding near the coasts—another reason to emigrate, according to Gebühr. "This ship suggests that the warriors were chasing some people off."



GHOSTLY REFLECTIONS *of times past, horsehides from a local butcher haunt a pond in a re-created Iron Age village at the Lejre open-air museum. Horse skeletons in Danish bogs suggest that Iron Age people sacrificed the animals and displayed their hides to signal the presence of a sacred lake.*

"THE NYDAM SHIPS were smaller and more primitive than the Viking ships," said Flemming Rieck. "But the most notable difference is that the Viking vessels could be both rowed and sailed. The Nydam ships had no sails. They were rowed only."

I stood on the shore of Als Sund, a saltwater sound two miles from Nydam Mose, with Rieck, a maritime archaeologist at the National Museum of Denmark and director of the Nydam excavation. After a week of rain the spring sun radiated intense light but little heat. Chins tucked in our windbreakers, Rieck and I stared at sailboats bobbing on the whitecaps.

"At some point between the Nydam ships and the Viking ships," he said, "Scandinavians began using sails." He spread his arms into the stiff breeze. "No one can say why it took so long for them to use the power of all this wind."

Rieck knows Nordic ships. He has built, sailed, and rowed two authentic Viking longboats. With a sandy white beard and ruddy complexion, he looks every bit the mariner and moves with the balance of someone raised on pitching decks. Now he plans to build a copy of a Nydam ship, guided by his understanding of how the ships were used.

"We know this creek was wider and deeper 1,700 years ago," he said, pointing to a brook that empties into the sound. "The Nydam ship measured six meters [20 feet] between the oar tips and sat only about 70 centimeters [28 inches] down in the water. It could have gone up that creek." Upstream the warriors would have raided villages and escaped by quickly rowing out.

Hundreds of years later Viking shipbuilders used this design, but they modified the hull. In

ONCE ROWED ON NORDIC SEAS, *this 75-foot oak warship was sunk intact at Nydam around A.D. 350. Now displayed in Schleswig, Germany, it is the oldest example of a hull made with overlapping planks—blueprint for Viking vessels some 500 years later, which would also add sails. Says archaeologist Flemming Rieck, "It's the great-great-grandmother of all Viking ships."*



my notebook Rieck penciled the simple, bowl-shaped cross section of a Nydam ship's hull; beside it he drew the fatter belly of a Viking ship. The latter bulged out on either side of the keel before rising to the gunwales. More haunches than hull, the larger Viking ship sat high in the water. With a deep keel and a sail to harness the wind, this craft could handle the open ocean. It enabled the Vikings to cross the Atlantic, while the Nydam ships stayed close to shore and probably crossed nothing broader than the English Channel.

Archaeologists assume that the Nydam warriors came from somewhere in Scandinavia, but no one has found their bones. They may have been cremated. Nor is there evidence that they moved in with the locals. Survivors may have been permitted to carry off the dead for proper burial in their homeland, which Rieck thinks lay well north of here.

"The wood in the two oak ships didn't grow in southern Denmark or England back then," he said, "but it grew in southern Sweden, along the Baltic coast, and possibly in parts of northern Denmark. As for the pine ship, I think that's from eastern Sweden. There was no pine that large growing in Denmark then."

As we turned to walk up the beach, I asked Rieck if he thought Europe was a safer, more humane place today than it was in the Iron Age.

"In the Iron Age there was much instability," he said. "If you want to compare it with the last century and a half, well, we Danes were at war with the Prussians or Germans in 1848, 1864, and 1940. I don't think the Iron Age was necessarily more brutal than today."

His sobering words would stick with me long after the mud of Nydam Mose had dried on the soles of my boots. □

In a replica of a World War I-era open-cockpit biplane called the *Silver Queen*, three adventurers retrace the first air route from Cairo to Cape Town.

QUEEN OF AFRI

N {OF THE} CAN SKY



{ JUNE 24, CAIRO, EGYPT }

AT 500 FEET above a white-capped English Channel, rain danced on the wings and stung our faces. Our craft heaved in the low clouds and buffeting winds.

The U.K.'s Manston Radar advised, "Mike Yankee [our call sign], you are now leaving our area." Then the English voice came again, "Mike Yankee, I understand you are the Vickers Vimy. Is that correct?"

"Affirmative. We are en route to Cape Town."

"Brilliant!" The radio crackled with emotion rarely heard from air-traffic controllers. "Best of luck, and Godspeed!"

As we fly over Egypt three weeks later (left), that cheery send-off echoes in my headset, but "Godspeed" seems unlikely. Cruising at 75 miles an hour, it has taken more than 40 hours of flying to reach Africa. Wind keens in 112 bracing wires, and twin 350-horsepower custom-built BMW engines churn out their deafening drone. Behind my nose-gunner's seat, wedged shoulder to shoulder in the cockpit, are chief pilot Mark Rebholz, far left, and copilot John LaNoue. Mark has 20,000 hours of flight experience as a jetliner captain and a passion for early aviation. John, a film set builder, led the construction of our plane—a painstaking replica of a World War I-era Vickers Vimy. With a 68-foot wingspan it is the world's largest airworthy biplane. Designed to drop bombs on European battlefields, the twin-engine Vimy was produced too late for wartime service but soon showed its mettle as a long-distance flier. In 1919 two British airmen made the first nonstop Atlantic crossing in a Vimy and a pair of Australians

ARTICLE AND PHOTOGRAPHS BY PETER McBRIDE

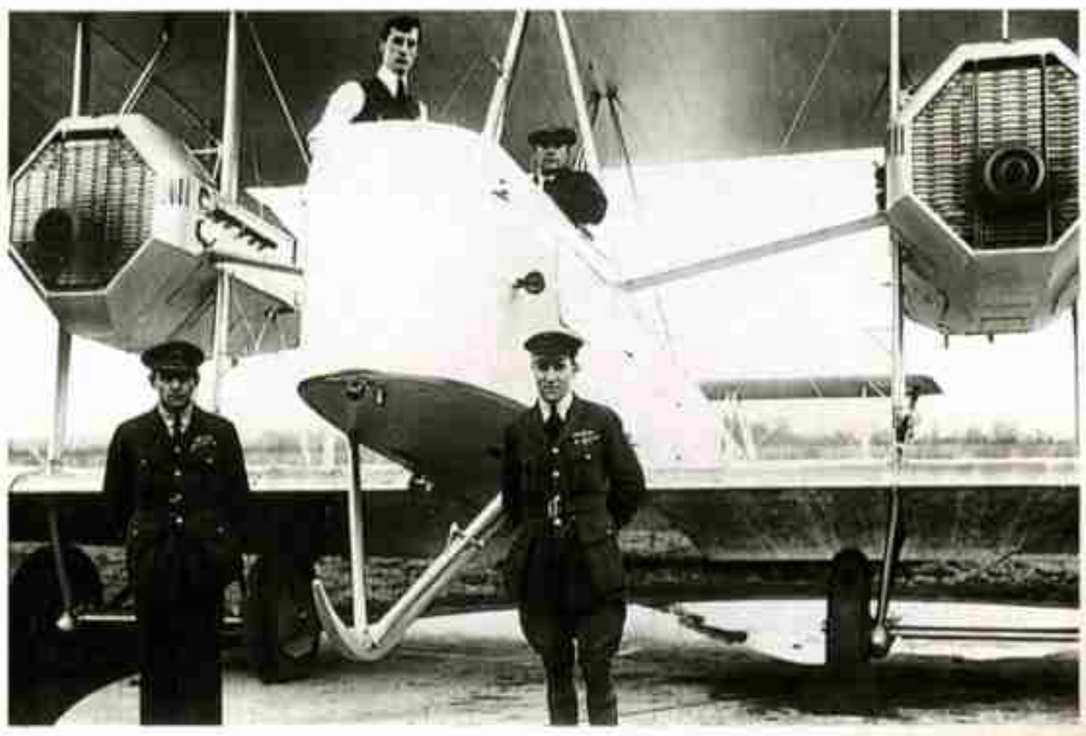
claimed a £10,000 prize for the first England to Australia flight.

To link its far-flung empire by air, the British government prepared runways with fuel caches every hundred miles along a route through eastern Africa, after which London's *Daily Mail* newspaper offered £10,000 to the first aviators to reach Cape Town, South Africa, from England. In 1920 five teams accepted the challenge, including two South Africans—Pierre van Ryneveld and Quintin Brand—flying a Vimy named the *Silver Queen.* All five teams crashed. The South Africans wrecked two Vimys, leaving a crumpled *Silver Queen II*, below, in Rhodesia (now Zimbabwe). Refusing to give up, they continued on to Cape Town in a third plane 45 days after leaving England. Both were knighted, but van Ryneveld and Brand were awarded only £5,000 since they failed to complete the trip in their original craft.

Our Vimy first proved its durability in 1994 when owner Peter McMillan re-created the 1919 England-to-Australia passage.* Now Mark, John, and I, after three years of scraping together funds and preparing to follow the South Africans' route down the length of Africa, are airborne. We carry electronics and detailed maps our predecessors didn't have, but we still must cross 11 countries and two war zones and contend with bush airfields, mountain ranges, limited fuel access, and winter in the Southern Hemisphere. We will likely need that Godspeed.

*See "The Vimy Flies Again," NATIONAL GEOGRAPHIC, May 1995.

"This was a bootstrap operation," says writer and photographer PETER MCBRIDE, who helped raise funds for the flight. This is his first article for the GEOGRAPHIC.



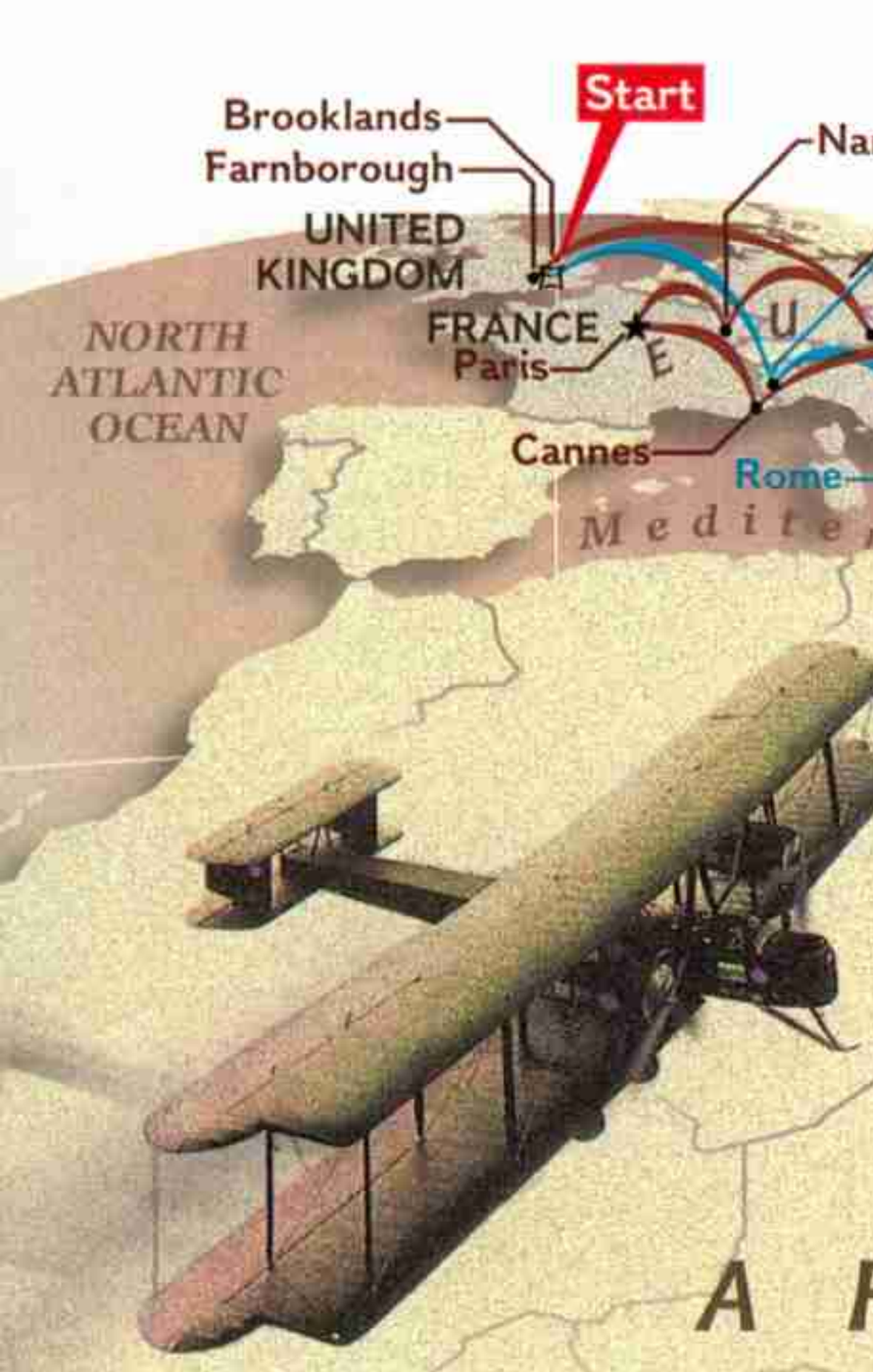
Hopscotching Africa's eastern rim, guided only by a compass and sketchy charts, van Ryneveld and Brand (above, in foreground) flew under the long wing of British colonial power. Eight decades later untangling aviation red tape often proved more challenging than navigation. Denied clearance by Sudan, we had to divert to the east of the original route (right, in blue), landing in Saudi Arabia and then lumbering nine hours down the Red Sea to avoid Ethiopian jets bombing Eritrea.



BROOKLANDS MUSEUM, SURREY, U.K. (TOP); DAVE BECKER COLLECTION

{THE SILVER QUEENS}

BEATING THE ODDS



VICKERS VIMY
Length: 44 feet
Height: 16.17 feet
Wingspan: 68.33 feet
Cruising speed: 75 mph
Range: 18 hours at low altitude

LOGBOOKS

{1920}

2/4 Brooklands aerodrome *to* Turin

2/5 Rome

2/6-7 *Departs Rome, refuels at* Gioia del Colle, *then makes history's first nonstop Mediterranean crossing. The 640-mile flight to* Darnah *takes 11 hours and is made after dark to reduce heat stress on engines. Continues on to* Salum.

2/9 Cairo

2/11 *Wrecks south of Cairo near* Wadi Halfa.

2/22 *Flight resumes in second Vickers Vimy,* Silver Queen II.

2/23-26 Khartoum, Mongalla, Kisumu

2/27 *Arrives at* Shirati. *By now four teams have dropped out of the race. Van Ryneveld and Brand are the only fliers still attempting to reach Cape Town.*

2/28-29 Mbala, Ndola

3/2 *During stopover at* Kabwe, Silver Queen II *mires in mud. Locals drag plane free, and she continues on to* Livingstone.

3/5 *Well-wishers at* Bulawayo *welcome flight with parade and feast.*

3/6 Silver Queen II *wrecks leaving Bulawayo.*

3/17 *Flight continues in plane borrowed from South African Air Force. Stops this day at* Serowe, Palapye, Pretoria.

3/18-19 Johannesburg, Bloemfontein

3/20 Beaufort West, Cape Town

{1999}

6/1-3 Brooklands, Farnborough, Munich

6/10-11 Nancy, Paris

6/16-21 Cannes, Taranto, Corfu

6/22 *Crosses Mediterranean in 9.5 hours—the team's longest nonstop flight. Lands at* Alexandria.

6/23-27 Cairo, Luxor, Jeddah

6/29 *Intercepted by French Mirage fighter jets based in* Djibouti.

7/4 *Heads south from Djibouti. Makes it across the embattled Ethiopia-Somalia borderlands, but fierce head winds force a return.*

7/12 *Leaves Djibouti after a week of delays. Flies a grueling eight hours to* Mandera.

7/13-18 *Stops at* Nairobi, Lake Naivasha, Chyulu Range. *Detours to* Mount Kilimanjaro.

7/19 *Near Chyulu Range, team narrowly escapes disaster when crosswind catches plane, driving wing into runway.*

7/21-23 Arusha, Dodoma, Mbeya, Lilongwe, Lusaka, Livingstone

7/24 *Passes over* Victoria Falls. *Welcome at* Bulawayo *includes parade and the same dinner prepared for van Ryneveld and Brand 79 years before.*

7/27-29 Pietersburg, Pretoria, Bloemfontein, Beaufort West, Cape Town

Historical place-names shown in parentheses.

{ JULY 12, ETHIOPIA }

Not quite dawn, already 90°F. Unable to rouse air-traffic controllers and without a valid flight clearance, Mark and John take off from Djibouti on July 4, banking south toward Ethiopia in a hazy head wind. Heavy fighting between Ethiopia and Somalia dominated preflight discussions, with anxious talk of forced landings, hostage situations, and roads full of trigger-happy soldiers. To allow more fuel onboard, I travel ahead to Kenya, hoping luck will blow south. It doesn't. The Vimy reaches only 8,800 feet and covers less than 200 ground miles in four hours. Exhausted by arm-straining turbulence and relentless head winds, Mark and John turn back. A week of faxes and sleepless nights later they secure a flight clearance for July 12. Again the *Silver Queen* dodges head winds, right, landing at Mandera, Kenya, after eight numbing hours. Mark calls it "the most demanding flight of my career."







"You are making history," said a grinning army officer, gesturing at the only airworthy Vickers Vimy in the world, now parked on his isolated base in northern Kenya. Word of our arrival spreads quickly through Mandera, a predominantly Muslim hamlet tight against the Somali and Ethiopian borders. That night local pilots share their modest accommodations with us.

At five the next morning we find schoolgirls in billowing purple uniforms waiting by the *Silver Queen*, notepads poised, eager to learn about what they call our "time machine" (far left). "We have heard of the Wright brothers," one says, "but what is this, and why are you here?" Mark responds with an impromptu aviation tutorial.



SILVER QUEEN

Everywhere the aircraft demonstrates its power to fascinate. Dodging storks and potholes on takeoff from Mandera, we fly eight and a half hours to Nairobi's Wilson Airport. Despite being two weeks overdue, we are met by cheering crowds.

The expedition's education team joins us in Nairobi. Selected in an essay contest, five students from five countries—the youngest 14 years old, the oldest 19—will follow the flight on the ground from Kenya to South Africa, led by tutors Mick Follari and Matt Bresler. Miriam Alube, a 19-year-old Kenyan, is the first student to go up in the *Silver Queen*. She lands crying, overwhelmed by the experience of flying in an open cockpit for the first time.

By Lake Naivasha in the Great Rift Valley the whole group joins friends and supporters at the home of elephant researchers Iain and Oria Douglas-Hamilton for an evening of classic bush hospitality (left). But our lengthy delay in Djibouti has left us little time to relax. Next morning we set off again (below), scores of waving hands urging us skyward.







{ JULY 16, KENYA }

Saluting another large, lumbering creature, the Vimy dips a wing to elephants browsing on the golden plains of the Masai Mara Reserve (left). With the stress of crossing war-torn Ethiopia behind us, we revel in peaceful flying. Zebras, gazelles, and wildebeests roam just a thousand feet below. We have had no trouble with our engines overheating since John cut away large pieces of the cowlings in Egypt. But the challenge of Kenya's high elevations remains.

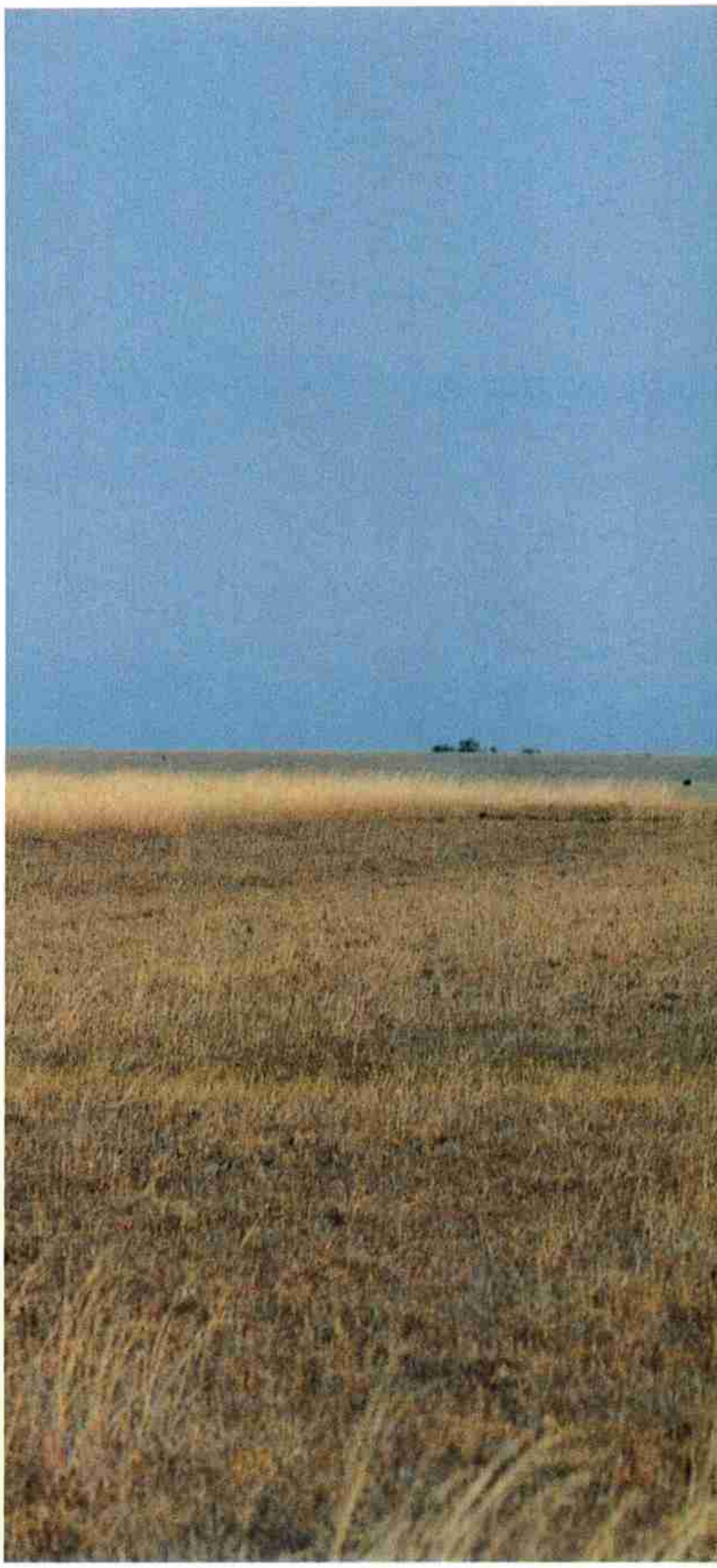


Taking off from central Kenya, we are confronted again with the *Silver Queen*'s limitations and reminded that every flight is a test flight. Weighted with fuel, she refuses to climb in the thin air above a high-elevation runway. Skirting treetops, Mark waits for fuel to burn off, noting in his log, "Too heavy if any obstacles." Three hours later we touch down on a grass strip in the Chyulu Range north of Tanzania. Apprehensive Masai examine us from a distance (top), then despite language barriers are quickly fascinated by our craft. One drums gleefully on the fabric-covered fuselage (center).



Detouring to Tanzania, Mark and John push the *Silver Queen* to 12,000 feet in the cooler air that wreathes snowcapped Mount Kilimanjaro (left). We're rewarded with a dazzling view of Africa's highest peak.





{ JULY 19, KENYA }

Near disaster strikes after the thrill of Kilimanjaro. A crosswind catches the *Silver Queen*'s wings, and despite both pilots' quick reactions on the heavy controls, the starboard wing gouges into the dirt runway (right). "We almost cartwheeled and rolled up into a ball," Mark says, slumping in exhausted frustration (above). The damage: a bent aileron control—and another delay.

We cannot afford to repeat our predecessors' misadventures. Van Ryneveld and Brand wrecked two Vimys—one south of Cairo and another leaving Bulawayo, in today's Zimbabwe. They finished their journey in the *Voortrekker*, a DH-9 borrowed from the South African Air Force. There is no second Vimy for us, and if a quick repair isn't possible, Mark will run out of leave from his job and have to abandon the flight. Morale low, weary to the bone, Mark and John head back to Nairobi in a friend's modern plane, hoping to find parts and locate fuel for the rest of the trip. I stay behind to secure our battered *Silver Queen*.

Eight hours later John returns, parts in hand (far right). We're offered another night of Kenyan hospitality at a home three hours' walk from the airfield. The next morning we trudge back through tick-infested grasses crisscrossed by lion tracks, eyed by giraffes and antelope. With more ingenuity than equipment, John revives the plane he built. Having located a fuel cache in southern Tanzania, Mark rejoins us July 21. Spirits lifting, we continue our southward journey.

SILVER QUEEN

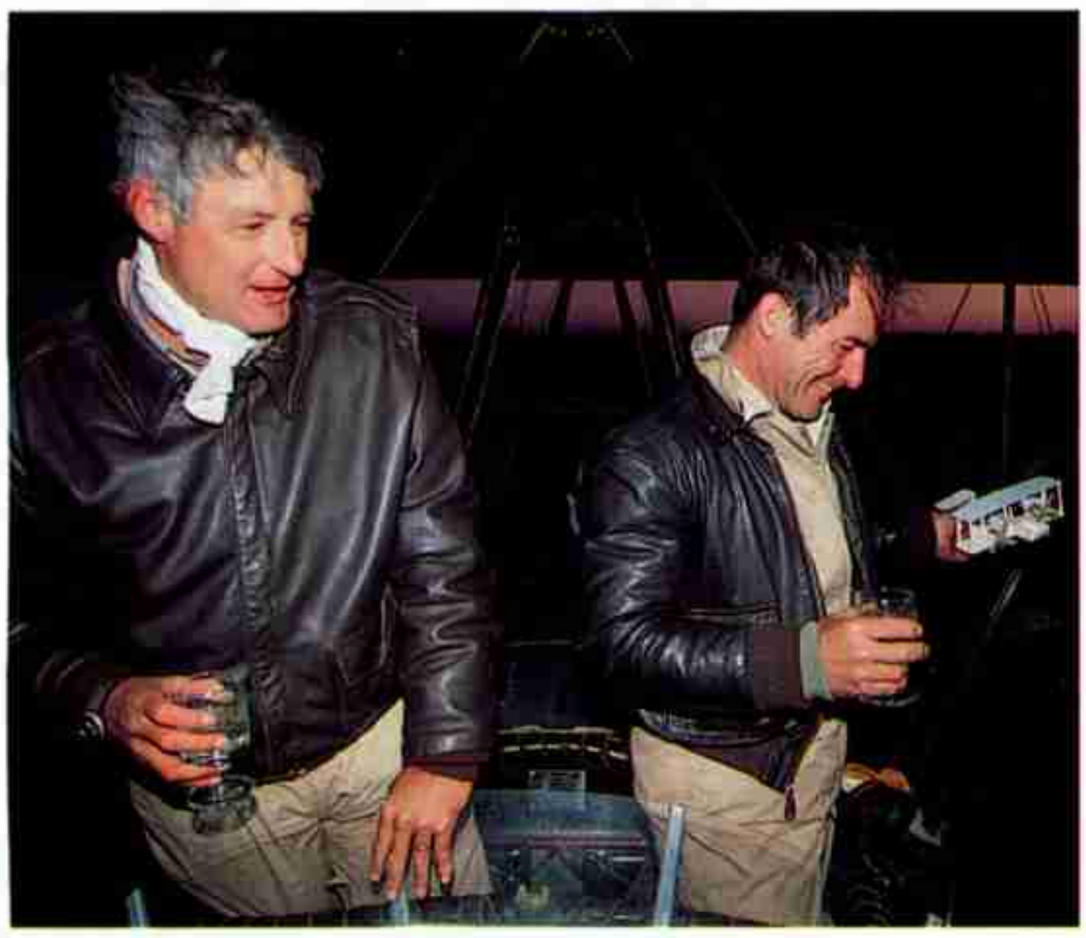






{ JULY 21-29, TANZANIA TO SOUTH AFRICA }

"I don't just bore holes in the sky," Mark tells me, "I fly with a purpose." When he's not piloting people or cargo, he's trying to keep aviation history alive in the sky. The effort saps our bodies but offers rewards we did not anticipate: We soar across earth-splitting Victoria Falls (facing page) at the very spot where in 1920 Quintin Brand made the first aerial photograph of the 355-foot-deep chasm.



As we cross Tanzania's forests, scattered smoke plumes are the sole signs of habitation. Turning onto a grass landing strip in Mbeya, we expect to find only a missionary pilot and his personal fuel reserve. But before our 11-foot propellers stop whirling, hundreds of children and adults (top) pour onto the field, encircling the *Silver Queen* with Swahili cheers and toothy grins. Their enthusiasm buoys us through three days of dawn-to-dusk flying over Malawi and Zambia. From the Zambezi River we race through western Zimbabwe, the setting sun on our tail. In Bulawayo a marimba band and more than 2,000 well-wishers salute us, cameras flashing and champagne corks popping (center). A few in the crowd remember having seen the *Silver Queen* cut through the sky 79 years before.

Grimy and worn, we sprint across South Africa in subfreezing winter weather. As we near our goal, rain, hail, and snow slash our faces, but the *Silver Queen* perseveres. On July 29, 1999, our Vimy at last sweeps across the shores of Cape Town (right).





{ EPILOGUE }

"Thank you for keeping a wonderful era alive," Quintin Brand's 76-year-old daughter, Mary, had said when our journey began. In Zimbabwe crowds swarm the *Silver Queen* as if she is not just a plane but truly a time machine—a portal to the days when courageous aviators opened the skies. Air travel 1920-style offers few comforts: 58 days after leaving England we arrive in Cape Town frozen, deaf, hungry, with distended bladders and windburned faces, wearing the same clothes we've had on for 9,000 miles. Yet flying in the open-cockpit Vimy gave us an intimate experience of eastern Africa's peoples and landscapes that few have shared. "My dear fellows," Pierre van Ryneveld said in a radio interview 36 years after his flight, "if you had been a millionaire, you could not buy an adventure like that." □



New Ca

France's Untamed

IF THESE WEATHERED TOTEMS could speak,

they would tell the vivid tale of an ancestor-

worshiping Kanak culture and the coming of the

French, about nickel mines, penal camps, and

armed revolt, and about a South Pacific island

wilderness unlike any in the world.

ledonia

Pacific Outpost



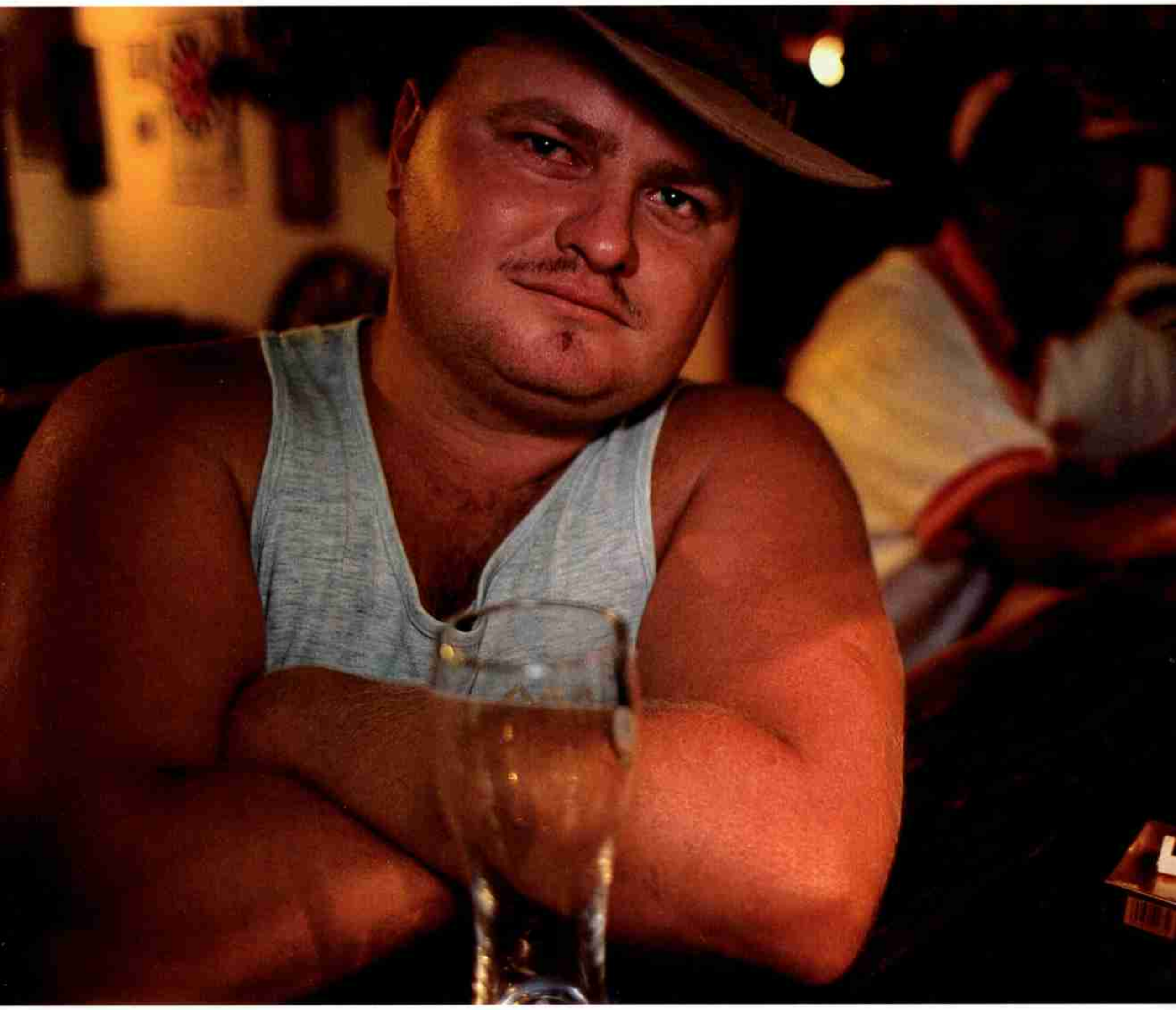
SEDUCED BY WARM SAND and high wages, young professionals from France find the living easy in Nouméa, the beach-fringed capital of New Caledonia, a French overseas territory. Except for package tours from Japan, tourists are fairly scarce, put off by high prices.

A GLOWING MIST at sunset sweeps over a steep mountainside on Grande Terre, the archipelago's 250-mile-long central island. Three-quarters of the island's 3,400 native plant species are endemic; many are relicts from the age of dinosaurs.



In the South Seas beauty pageant, New Caledonia always gets shown up by its flashier, come-hither rivals Tahiti and Bora-Bora, all three island contestants wearing the French tricolor sash. New Caledonia's invisibility hardly seems fair: The small archipelago can boast of vast coral gardens, unbroken rain forest, and cliffs that plunge into turquoise seas.

Maybe it's a personality thing. The indigenous Melanesian peoples, called Kanaks, and the French inhabitants have never cared much for each other. Compared with



By THOMAS O'NEILL
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by PETER ESSICK

the Polynesian peoples of Hawaii, Tahiti, and other islands to the east, the Melanesians of the southwest Pacific have proved more resistant to colonization. Animosities on New Caledonia peaked during the 1980s when Kanaks, seeking independence, seized towns and torched the homes of white settlers. French troops were flown in to crush the uprising. Since then tense times have given way to increased power sharing among the various constituencies and greater autonomy from Paris. It's no longer dangerous to travel the backcountry, or what locals call *la brousse*, the bush.



Riding a barstool, farmer Jean-Guy Clemen waits for a refill in Bourail, a stronghold of locally born French known as Caldoches. Many Caldoches trace their roots to early miners or to convicts deported here in the 19th century. Resentment of Caldoche dominance in local politics and business sparked a violent uprising of Kanak rebels in the 1980s.

Or maybe New Caledonia loses points because of scars. The archipelago's long, narrow central island, Grande Terre, contains the world's largest known nickel deposits, and more than a century of mining has left gouged plateaus with tailings dumped down their sides. The mining companies are making cleaner cuts nowadays, but with nickel providing 90 percent of New Caledonia's export revenues, the remnant but still abundant physical beauty of the place seems to barely turn the heads of local residents.

So who *does* give New Caledonia a second glance and speak its name? Parisians and other city dwellers in faraway France know its tropical temptations. They arrive each year to teach or work in the bureaucracy for nearly double what they would earn in their sun-deficient hometowns. Known as *métros*, short for *métropolitains*, or continental French, these transients live mostly in the sunny seaside capital of Nouméa, high-priced imports just like the made-in-France cheeses, wines, and fashions they can buy in the city's shops.

The Japanese know New Caledonia's attractions. They descend by the planeload to honeymoon at Club Med and other flower-scented resorts. They expose most of their film, it seems, at Nouméa's topless beaches, where tour buses linger and back up traffic.

More than a few Americans have vivid memories of the place. Some 75,000 American soldiers were billeted on Grande Terre in 1942, during World War II. The island served as a staging area for attacks against Japanese forces in the Solomon Islands during the Battle of Guadalcanal. Neighborhood names in Nouméa like Motor Pool and Receiving recall the Yank presence. Ask baby boomers about New Caledonia, and many will light up like their TV sets of old and say, "Isn't that where Ernest Borgnine and his men always talked about going for R & R on *McHale's Navy*?"

These are amateur passions, say the true believers in New Caledonia, the ones who turn their backs on the beaches and the bistros and stand exultant in the dim, steamy forests and the dusty scrub, seeing what to them comes close to an unconditional paradise. "Ask any

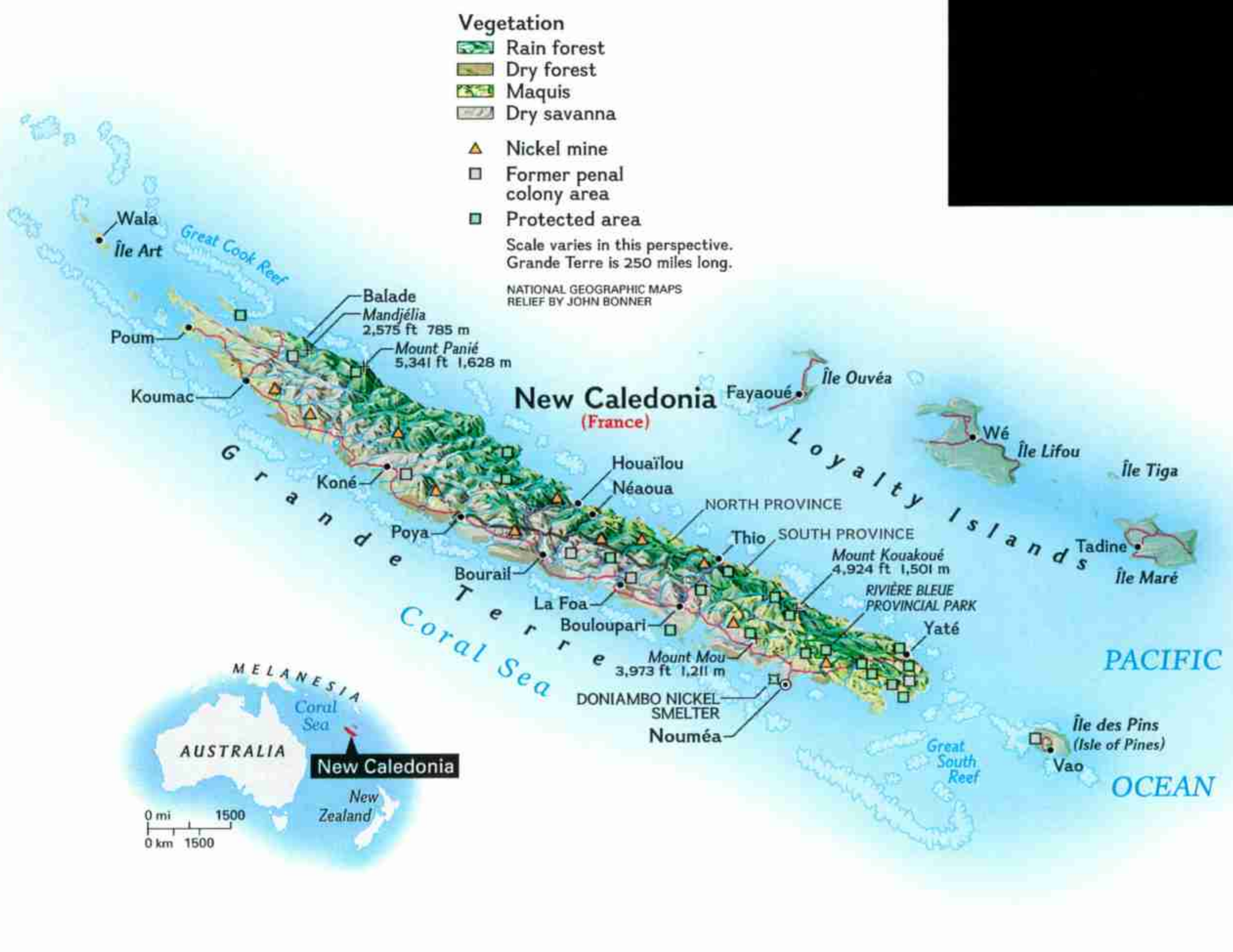
botanist about New Caledonia, and he or she will know it as one of a handful of special places in the world," said Pete Lowry, a botanist with the Missouri Botanical Garden, a leading research organization headquartered in St. Louis. Lowry was standing with me on a patchy, unshaded hillside on the arid western side of Grande Terre, a spot that Club Med guides would have sneered at. "You tell botanists you are coming here," he continued, "and they will envy you and wish they could visit here once in their lifetime."

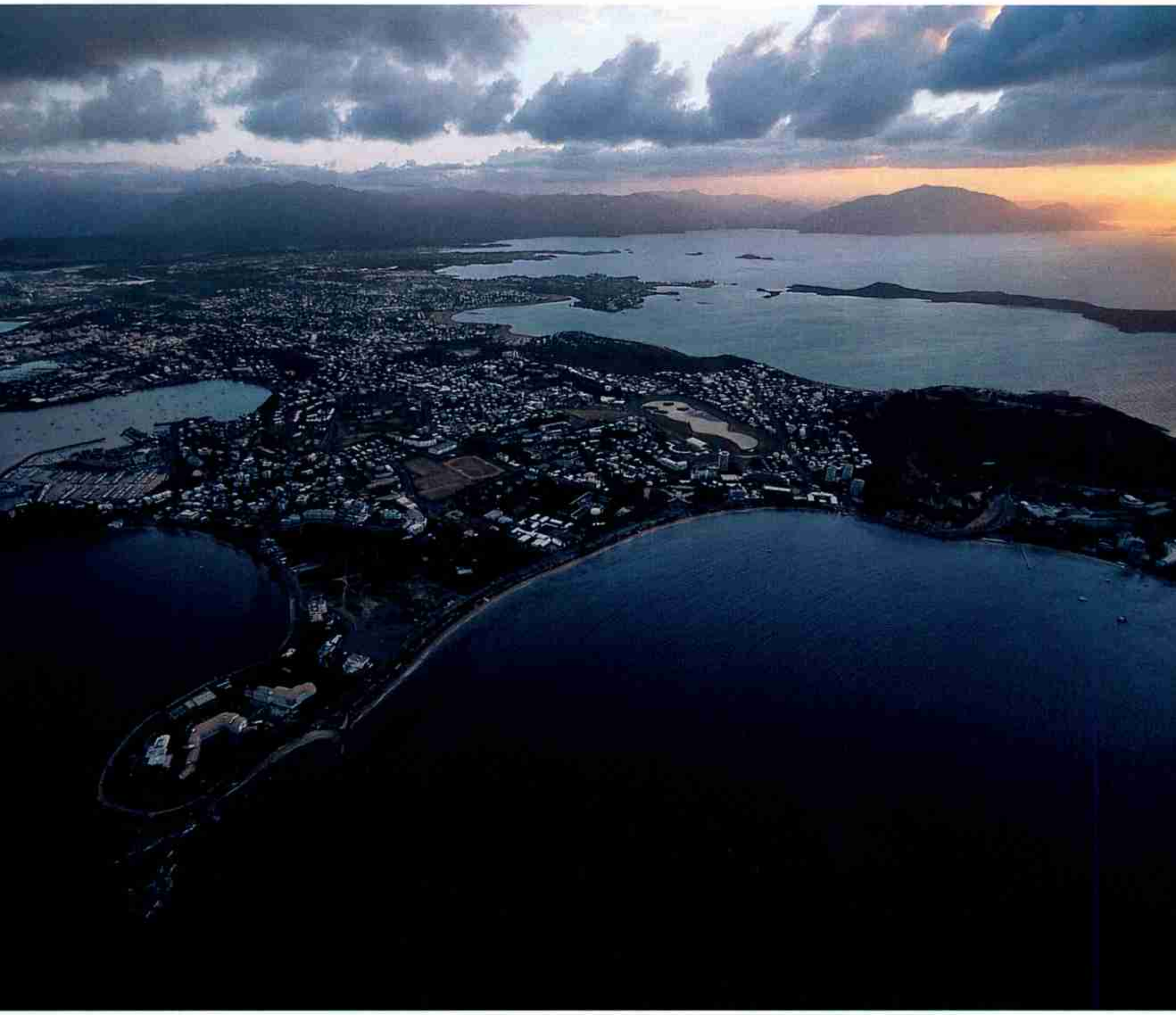
Lowry, who works out of Paris and heads the garden's Africa and Madagascar program, includes New Caledonia in his beat. He has worked here regularly and fervently since 1982 when he came to collect plants as a graduate student. Lowry agreed to give photographer Peter Essick and me a highlight tour of New Caledonia's famous flora.

To reach that patchy hillside, Lowry had pulled our four-wheel-drive vehicle off the main north-south highway and ground up an abandoned mining road. Nothing around us grew higher than four or five feet; the vegetation looked as if it belonged in an overgrown city lot. Below us, between high ground and

Waterfront capital, Nouméa spills across a multi-limbed peninsula. The metropolitan area is home to more than half the territory's 200,000 people. A cloud-catching mountain range splits the main island into wet and dry zones. The dusty west is home to cattle spreads and Caldoches, while the lush east is dotted with villages of the indigenous Kanaks.







the sea, the metal roofs of homesteads glinted like mica shards. Behind us clouds smothered the tops of the 3,000-foot mountains of the central massif, whose jagged spine runs the length of the 250-mile-long island.

Lowry and I had been traveling together for a week, and often, hiking in the forest or poking along interior roads, he would stop, approach a plant, examine the leaves with the intentness of a jeweler, and then, with a whistle or goofy grin, say, "I may have found a new species."

In our vehicle up on the scrubby hillside Lowry was talking a blue streak about how to spot a healthy forest—"you look for that tight weave of green with no ground showing"—when he pounced on the brake and shouted, "There's one of my family!" That's how I met *Schefflera revoluta,* a tall skinny plant topped with a parasol of elongated tufted leaves. It is a member of Araliaceae, the ginseng family. Since he started pressing specimens on Grande Terre, Lowry has collected almost all 92 known species of Araliaceae in New Caledonia. Two dozen of them will enter the literature because of his discoveries. A lean, high-energy guy in his 40s, happiest when his field clothes turn colors from mud and leaf stain, Lowry slipped into the brush to clip a specimen. For the next

PETER ESSICK's first assignment for NATIONAL GEOGRAPHIC was as an intern 15 years ago. The story, "Model Planes," appeared in July 1986. Since then he has photographed 21 articles for the magazine, including "Hard Rock Legacy" in the March 2000 issue.

hour he sat in red dirt under a fierce sun and artfully arranged the leaves and stems for his plant press.

FOR TROPICAL-ZONE BOTANISTS like Lowry, New Caledonia is the ultimate specialty store, piled high with items unavailable anywhere else, many of them still awaiting discovery amid the clutter. A remarkable three-quarters of its 3,400 native plant species are endemic, unique to this speck on the globe. Going up the taxonomic scale, scientists estimate that about 14 percent of its 840 plant genera are originals. And out of 196 families, five are found only here, including Amborellaceae, whose single species, *Amborella trichopoda*, with its modest cream-colored flowers, may be the closest living relative to the first flowering plant, which arose about 135 million years ago. "A living fossil," scientists say of the rare plant, which Lowry and I saw growing on the humid slopes of several of the mountains we ascended, sweet *Amborella* receiving a nod as we passed by.

Of the world's islands, only Hawaii, New Zealand, and Madagascar have higher proportions of endemic flowering plant species. Given its small land area (at 7,174 square miles, the island group could fit inside New Jersey), this obscure French territory is unsurpassed for the condensed distinctiveness of its flora.

New Caledonia stands biologically apart largely because of its antiquity. Eighty million



years ago Grande Terre began to break off from Australia, formerly part of the supercontinent Gondwana, which also included lands we know today as South America, Africa, and Antarctica. The island, a splinter of continental crust, carried samples of late Cretaceous flora. Relict descendants of those plants survive on the island today. Eric Dinerstein, a scientist with the World Wildlife Fund, told me that when he finds himself in a stand of araucaria, a tall, spindly Gondwana pine, "I feel like I'm walking in a forest the dinosaurs knew."

Not only did Grande Terre's primitive vegetation develop in isolation nearly a thousand miles from Australia, the nearest large landmass, but the flora also underwent a tremendous speciation, in part because some plants could adapt to the nearly toxic ground. At one time a sheet of highly mineralized rock covered much of Grande Terre. Erosion removed large areas of it, but substantial parts of the island, particularly on the southern half, are still covered by a rust-colored, nickel- and magnesium-enriched soil scientists call ultramafic. It is where the mines are located, and it is where nine out of ten of the plant species, including *Schefflera revoluta,* are endemic.

The conservation community, more aggressive and partisan than the research establishment, began to focus on New Caledonia in the early 1990s after the archipelago was identified as a global "hot spot"—a tropical region of exceptional diversity and endemism facing serious threats to its ecological integrity. Investigators from influential groups such as the World Wildlife Fund and Conservation International conducted quick surveys of Grande Terre and returned home with dire warnings of extinctions and habitat loss. They cited mining and timbering, uncontrolled brush fires, an inadequate reserve system, and, most disturbing, an utter indifference to conservation by most New Caledonia residents.

That blasé attitude struck me continually during the month I spent traveling on Grande Terre. I visited many wild areas, some of them protected, a few of them highly endangered, and almost all of them unvisited except for the occasional lost cow, a passing Melanesian hunter with rifle or slingshot, or, as photographer Peter Essick discovered on the mossy summit of Mount Mou, a shivering, half-naked French model submitting to a fashion shoot.



With only weekend hunters to fear, a herd of non-native deer pounds through a forest on Grande Terre. No large predators inhabit the island, which broke off from the Australian landmass 80 million years ago. Citing the loss of dry forest to overgrazing and fire, environmentalists press for new preserves to protect hundreds of threatened plant species.

A STRICT DIET of tramping the bush and reading scientific papers about plant life made it easy to forget that human life on the archipelago is as entrenched and seemingly as diverse as the vegetation. The population of New Caledonia, which includes Grande Terre and the handful of younger, smaller islands to the east, approaches 200,000 people. Almost half are Melanesian, another third are European, and the remainder include Indonesians, Vietnamese, Wallisians, French West Indians, Tahitians, Vanuatuans, and Arabs, many of whose ancestors came to work in the mining industry.



About 60 percent of the population, including most of the Europeans, has crowded into the vicinity of Nouméa. The French founders picked a lovely spot for their port city, a peninsula ringed by sheltered coves. There is almost nothing old left downtown; the colonial-era buildings with their broad verandas and their tall windows open to the trade winds have been mostly torn down to make room for low, functional office boxes. Nouméa fancies itself in part as an imported slice of the French Riviera. Villas and condominiums command the hillsides above a seafront lined with marinas, soft beaches, and open-air cafés. Residents stroll the waterfront streets with baguettes tucked under their arms. Productivity, one assumes, can't be very high.

Old World facade of St. Joseph's Cathedral, built by convict labor, outshines its modern surroundings above Nouméa's harbor, a popular stop for round-the-world sailors.

Gérard Orfila, a law professor at the University of New Caledonia in Nouméa, complained that visitors never see the "real" Nouméa. An immigrant from Algeria, the professor guided me through working-class neighborhoods of modest bungalows, where even the simplest yard exploded with tropical flowers. We passed housing projects, the balconies strung with laundry, the walls sprouting graffiti. From a hill above a surviving piece of forest, we looked down on squatter shacks, their metal roofs glaring in the midday sun. And finally we came to Nouméa's most distinctive and least resort-like feature: the huge Doniambo nickel smelter minutes north of downtown, making itself known with thick clouds of smoke. Its presence has turned Nouméa into the South Pacific's most industrial city.

Cattle ranches and soporific frontier towns

lie scattered along the western side of the big island. The towns keep to the basics: food, gas, beer, cowboy hats, and sometimes a taxidermist shop, the source of the antlered deer heads that dress up most bars. The majority of people who live in the west are known as Caldoches, descendants of the early French. The French annexed New Caledonia in 1853, partly to keep it out of British hands but mostly to open a new penal colony. Some Caldoches trace their ancestry to the early convicts, many of them political prisoners who had revolted against the royalist government in France.

Almost all Caldoches are dead set against independence. They fear losing their land and political influence to Kanaks. Claude Metzdorf, a fifth-generation rancher, was lecturing me on how New Caledonian beef is superior to the Australian stuff when he suddenly admitted that he is not sure why France holds on to this prickly, expensive territory. "It is not staying here for our pleasure," he said. "There doesn't seem to be a military reason. Maybe since everything else around here is Anglo-Saxon, keeping this place allows France to play in the big boys' crowd."

The Kanak population is concentrated on the eastern half of Grande Terre and on the four Loyalty Islands eastward. Nearly 150 years of missionary work and decades of an apartheid-like French political system, which ended only after World War II, have gutted a native culture based on ancestor worship and communal labor. Still, Kanak villages continue to orient themselves around the ancestral thatched hut of the clan chieftain. And villagers still plant and harvest their sacred yams.

Many of the Kanak young are abandoning their villages to look for work and excitement in Nouméa. Naousse Weiri, a dreadlocked 27-year-old sculptor who is the father of five children and still hunts in the forest for food, told me he intends to stay in his village of Néaoua, in a lush mountain valley far off any main road. "I tell my friends that we belong to the forest, not the city," Weiri said. "Our political leaders want to fight for equality, but they're not doing enough to help the culture. Put a shop and a hospital and a school in my village. Then people won't leave."

INTO THIS INSULAR, conflicted world has come a brigade of high-profile environmental activists striving to convince both the locals and the outside world of New Caledonia's global importance. Lowry, the dogged, low-profile scientist, believes that New Caledonia will have difficulty commanding international attention simply because it lacks the marquee value of a Madagascar with its chameleons, lemurs, and other charismatic residents. Grande Terre claims no native amphibians, just one kind of snake, only skinks and geckos for lizards, and for native land mammals a mere eight species of bats. It does have rare birds, such as the notu—world's largest pigeon—gorgeous butterflies, and a largely uncataloged wealth of other insects.

"New Caledonia doesn't have the cute and cuddlies," Lowry admits. "Most people, especially here, don't realize that this island is jam-packed with tremendously interesting and important plants. I guess it's hard for the average person to get excited about plants."

Naturalists, however, have praised the island for its flora ever since the first Europeans walked its forests. That occurred in September 1774 when Captain James Cook came ashore on the northeast coast near the present-day village of Balade. Cook named the mountainous, cloud-hung island New Caledonia, after the Roman name for Scotland, which to his eye shared the same rugged contours. Johann Reinhold Forster and his son George, the expedition naturalists, almost died here after eating a poisonous fish but survived to bring back to Europe a compelling selection of specimens. Cook meanwhile made gifts of dogs and pigs, creatures new to the island and a cause of eventual extinctions and serious declines in the populations of native animals.

Numerous botanists, principally French, have followed, particularly in the past 125 years, their work aided by what Lowry calls "a benign forest where you don't have to be afraid of snakes and nasty bugs." In Nouméa I met one of the greatest of New Caledonia's collectors, Jean-Marie Veillon, a largely self-taught botanist. A slight, graying man who recently retired after 35 years with IRD, France's tropical research agency, Veillon first showed me the herbarium, a large, musky room of file cabinets filled with rare plant specimens. Seeing little room for a guest in his



book-piled office, he led me outside to a picnic table to talk.

Veillon is a Caldoche who grew up in the mining town of Thio, served in the French Army, and then, looking for any job, was hired in 1964 by IRD as its first plant collector. "I knew absolutely nothing about botany," he remembered with a laugh. "Fortunately I had a strong interest in nature, from days hunting with my father."

For his first collecting trip he ventured to the outskirts of Nouméa to pick through a remnant patch of forest. "It's gone now," he said ruefully. "It's an exercise trail." He grew more adventurous, going up and down the island's tallest mountain, Mount Panié, in one day bringing back 50 plant specimens from the 5,341-foot-high peak. Many of the plants were new to science. The collection now stands at 70,000 specimens.

Shortly before he retired last year, Veillon and two colleagues from IRD published a paper that reads like a call to arms for local and world conservation leaders. Surveying New Caledonia's network of protected areas—27 reserves covering about 3 percent of the land area—the authors found that the areas failed to protect most of the archipelago's 397 threatened plant species. The paper urged the territory at least to double the size of the reserve system.

In the island's South Province, which contains most of New Caledonia's population and almost all its protected space, local leaders recognize the problem but don't expect to expand the reserve system unless it can pay for itself. "Just having frozen areas where no one goes is a big financial burden for us," said Richard



Obtrusive neighbor, the Doniambo nickel smelter (left) exhales potentially hazardous smoke near low-income housing in Nouméa. Nickel rules the economy, making up 90 percent of exports. Nearly a dozen mining centers, like the opencast mine at Thio (below), operate on Grande Terre, which may hold as much as 40 percent of the world's nickel deposits.

Farman, deputy director of the South Province's Department of Natural Resources. "Fortunately tourism is a rising factor here, and we can't have tourists visiting mine sites. I see a big demand if we could establish hiking trails and overnight huts. It's ecotourism. Unfortunately our tour operators don't know what the word means."

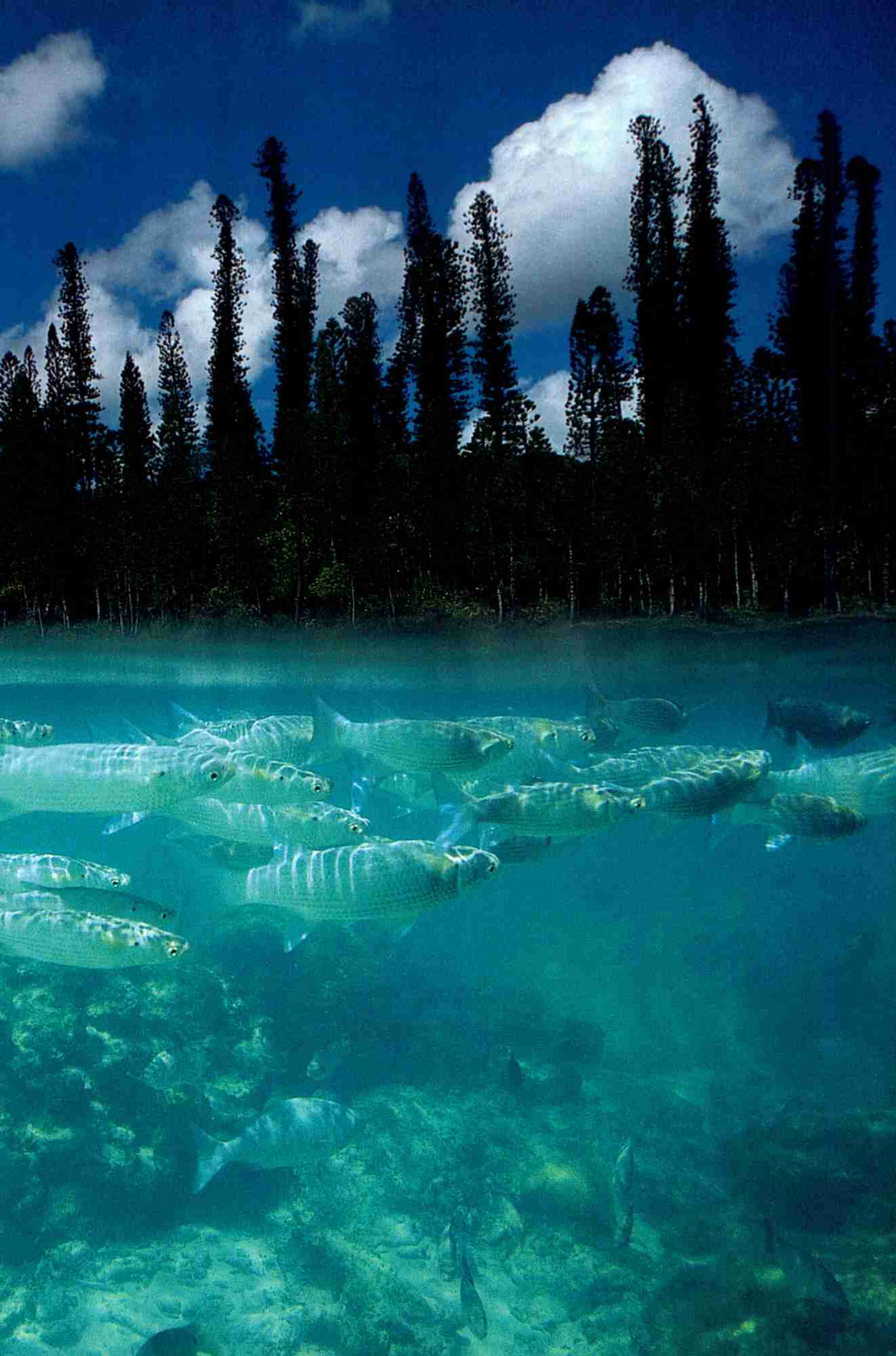
CONSERVATION will likely remain a low priority in New Caledonia until the territory settles its political future. In late 1998 voters passed decisively a referendum calling for more self-government. In response the French Parliament agreed to a gradual transfer of state powers. The territory's high commissioner, appointed by officials in Paris, has already begun shifting responsibilities to locally elected officials. A vote on independence is scheduled, but not until 2014.

Lowry, who is trying to raise money for researchers to map priority areas for plant conservation, believes time is still on New Caledonia's side. "We must remember that this is not a poor developing country where people desperately need the land for food," he said. "Everything is not being trashed as we speak."

Almost half of New Caledonia's original vegetative cover remains, a richness attributed to a historically low population density and to the seaward *(Continued on page 74)*



DRIFTING LIKE CLOUDS, a school of mullet visits a see-through lagoon on the Isle of Pines, one of New Caledonia's smaller islands. Captain James Cook landed here in 1774, intrigued by the tall araucaria trees and their potential as ship masts in case of emergency.







DAVID LIITSCHWAGER AND SUSAN MIDDLETON (ABOVE)

Camouflaging colors fail to protect two endemic pigeons—a cloven-feathered dove and a notu—from a Kanak hunter. A gecko (top left) emerges on a tree at dark. The forest contains leggy creatures like a crane fly (top right) and an orb weaver spider (bottom right). The native *Amborella* (bottom left) may be the closest living relative to the first flowering plant.



orientation of the Melanesian and French cultures. Lowry calls it "protection by neglect." Rain forest, formerly the dominant vegetation type and the one with the most endemic species, covers about 22 percent of the land, much of it confined to the high and inaccessible elevations. Maquis is the island's main vegetation type. Characterized by low branching plants, maquis grows at high and low elevations. Because maquis is associated with heavily mineralized ultramafic soils, humans have never cleared it for agriculture.

Almost nothing remains of the original dry forest. Characterized by a dense growth of deciduous trees 30 to 40 feet tall—a low ceiling compared with a rain forest—the dry forest covered large parts of the western, rain-shadowed side of Grande Terre. Most of it was chopped and burned to clear land for cattle ranching. Only fragments survive, few of them larger than 60 acres. Unless action is taken soon to fence off the remnant dry forest from heavy-footed cows and hungry deer, conservationists warn that within ten years hundreds of endemic plant species could disappear.

Outside Koné, the four-block-long capital of the North Province, a surviving patch of dry forest shows up in the surrounding ranchland like a spot of beard missed while shaving. Officials from the government's environment office broke a trail in front of me, dodging through a tangle of vines and slender trees. Joseph Manauté, a forester by training, told me that Veillon had been here a few weeks before and spotted a species of parchment bark tree listed as extinct. Veillon wept when he saw it.

Leading me through the dappled light, Manauté was eager to show that the unappreciated dry forest—the "forgotten habitat" he called it—has a flamboyant, unforgettable side. After a short hike, the browns and greens of the vegetation suddenly gave way to a clearing filled with brilliant red streamers. Large, tight crimson flowers climbed stalks ten feet high. These were the rare and beautiful *Captaincookia,* some more than a century old. This cloister of 30 plants was noticed by Manauté only a few weeks before. A number of the plants had been trampled by cows.

This forest patch, like most of the other remnants, survives only because the Caldoche landowner can't be bothered to cut it or because his cattle enjoy the shade it offers. Manauté has persuaded several ranchers to put fences around their patches of forest. But not all folks look kindly at government officials taking an interest in their property. Approaching one beery, sunburned rancher on a back road, we asked if we could photograph his niche of forest. No, and if he ever saw us on his land again, there'd be trouble. Understood.

New Caledonia claims one poster-ready success in the conservation field: the saving of the kagu, a short, flightless bird whose numbers by 1980 had dropped dramatically. Wild dogs in the rain forest were feasting on the easy target. A captive breeding program and reintroduction of the kagu into Rivière Bleue Provincial Park has created a stable population in the park of 450. Even so, the kagu remains endangered



French-speaking Kanaks in English-covered shirts hear the voices of their ancestors as they search for fish. Identities will stay fluid as New Caledonians continue their debate over whether to break free of France. Many favor independence, but obstacles such as racial tensions, erratic nickel prices, and land-use questions still must be navigated.

since its other habitats provide no protection.

Before I left New Caledonia, word spread through the "green" community that new populations of the kagu had been found, their cries heard in two remote river valleys in the central mountains. An owlet nightjar, presumed extinct after not having been seen in the past 118 years, was sighted by two British ornithologists in a densely forested river valley near Mount Kouakoué. At a restaurant in Nouméa, Christine Pöllabauer, a specialist in freshwater biology, told me casually that she had recently identified eight new species of fish on Grande Terre. Such discoveries show no signs of stopping, either, as various scientists reminded me, drawing circles on my map of New Caledonia to indicate areas not yet collected or surveyed.

In the coming years most news stories datelined New Caledonia will undoubtedly deal with the opening of new nickel mines, the writing of a new constitution, or, with luck, the announcement of a new nature reserve. But any botanist or zoologist who has ever worked here or studied the island's collections will know that practically every month the truly new is being reported in a scientist's dirt-streaked, rain-softened notebook: a new plant or fish or beetle. The possibilities seem almost endless, Lowry said, standing with me atop a height called Mandjélia. To the south ran mountain after mountain of rain forest, a surging flood of green. "Probably no human has ever been in some places down there," he mused. "Wonder what I'd find." □



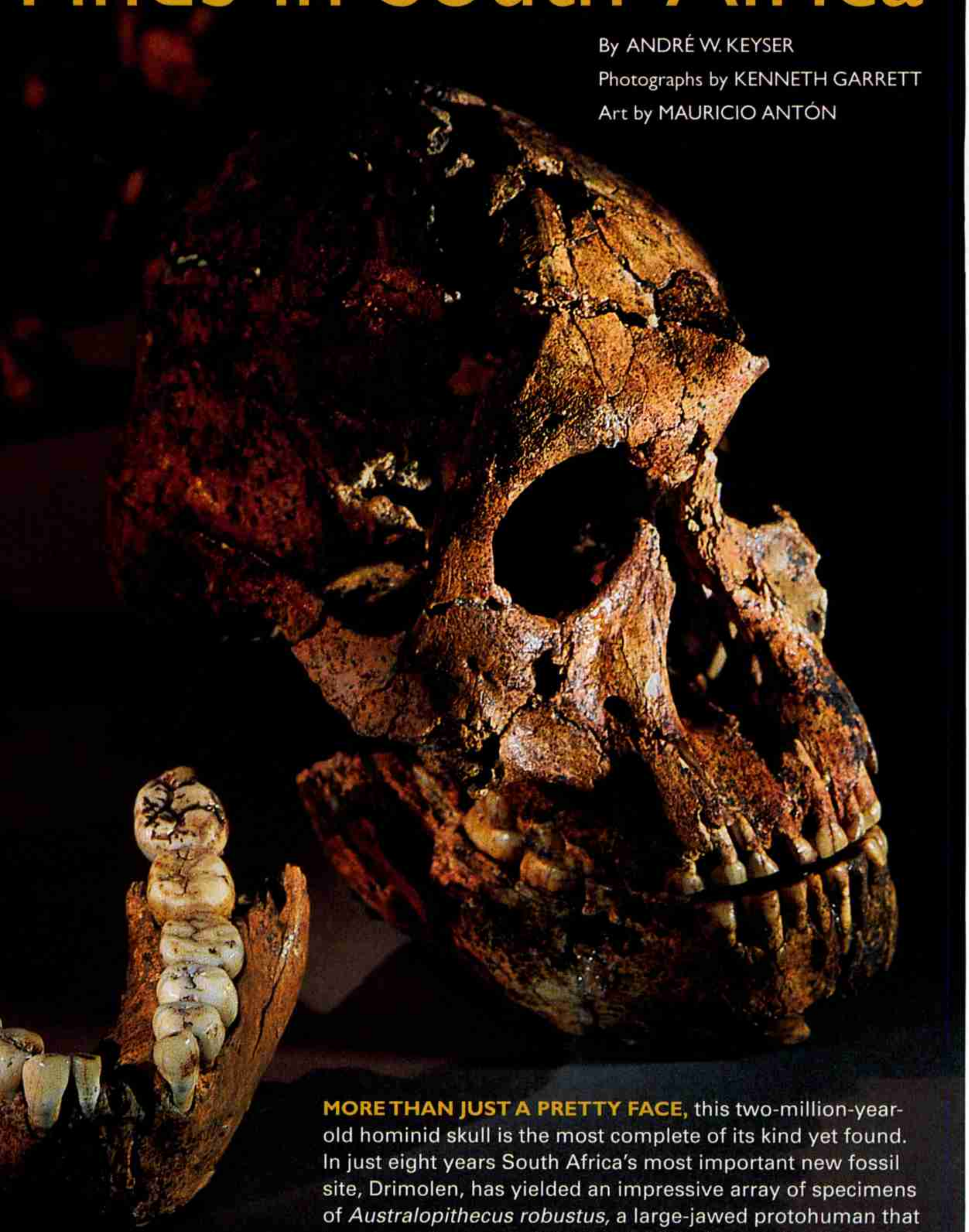

New

Finds in South Africa

By ANDRÉ W. KEYSER

Photographs by KENNETH GARRETT

Art by MAURICIO ANTÓN



MORE THAN JUST A PRETTY FACE, this two-million-year-old hominid skull is the most complete of its kind yet found. In just eight years South Africa's most important new fossil site, Drimolen, has yielded an impressive array of specimens of *Australopithecus robustus,* a large-jawed protohuman that became extinct on a side branch of the human family tree.

DISCOVERY OF A LIFETIME

I was just a geologist looking for a retirement hobby when I found Drimolen in 1992. Poking around the grassy hills northwest of Johannesburg in search of a small fossil site to excavate, I stumbled across this abandoned limeworks and found baboon and elephant fossils near a cave entrance. I was thrilled, but I had no idea that I would find a two-million-year-old hominid tooth within a week or that this would become one of the richest hominid sites in southern Africa—a region dotted with important sites. My hobby exploded on me.

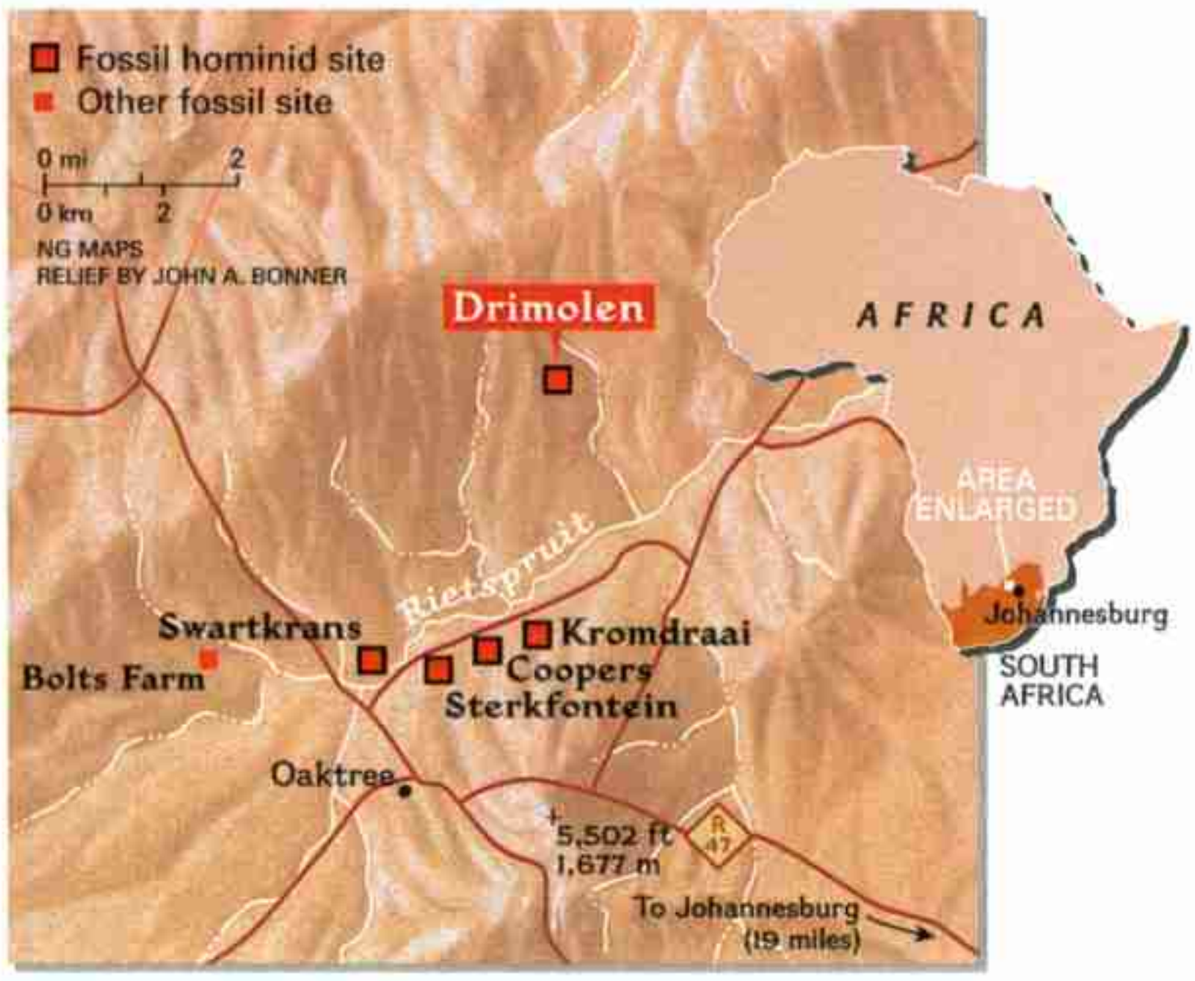
So far we've excavated about 5 percent of the 20,000-square-foot Drimolen site (above), and already we've found almost 80 specimens of *Australopithecus robustus*—also known as *Paranthropus robustus,* meaning "beside man" and "strongly and stoutly built." The *robustus* name can be misleading; its body was no larger than a modern chimpanzee's. Its jaws,

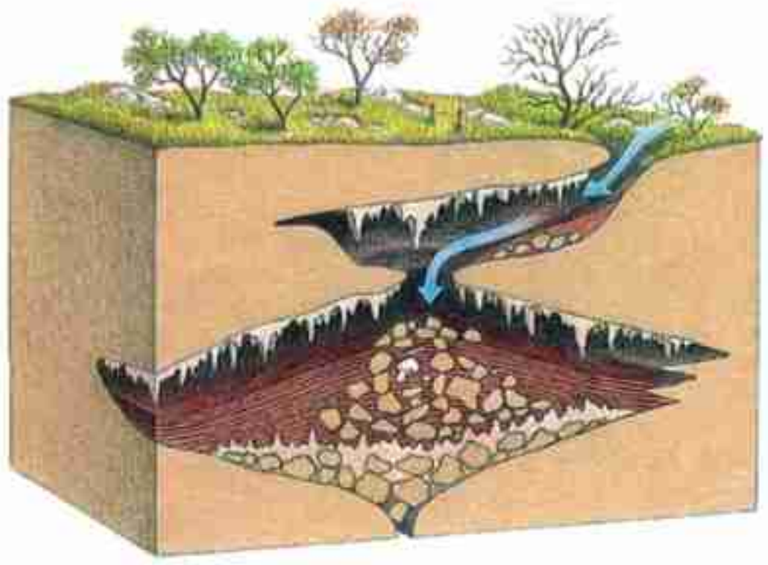




reasons we're still piecing together. At Drimolen many of the specimens we've found have been juveniles and infants, perhaps because their smaller size made them easier prey for carnivores like saber-toothed cats and leopards. One popular theory is that in order to avoid competition from scavengers like hyenas, leopards ate their prey in trees that clustered near caves, and the remains of their meals fell into the cave entrances. I think it's more likely that the cats cached their prey in the caves.

However the bones got there, we know what happened in caves like this once they did. After collecting in an upper chamber, bones and sediment were washed by flash floods into a lower cavern, where they gathered in what's called a talus or debris cone (bottom). As lime-bearing water dripped onto the cone from the cavern's roof, the material slowly calcified into a hard rock called breccia. This is what we find—huge blocks of breccia brimming with fossils, mostly small animals like rodents but also larger animals like antelopes, elephants, cats, and baboons. In fact, it's the animals we find that help us determine how old hominid fossils are, since many animals have identifiable evolutionary adaptations within specific frames of time. What we'd really like to find are some pig fossils: During this period ancient pigs changed so rapidly and distinctly that they make great timekeepers.





premolars, and molars, however, were massive—much larger than those of a modern chimp or human, or of all but one other closely related hominid, East Africa's *Australopithecus boisei*. Even though its evolutionary line dead-ended, *A. robustus* lived successfully for a million years—eight times the reign so far of modern humans—and even coexisted with early species in the *Homo* genus. So the "beside man" designation certainly fits.

As with other early hominids in southern Africa, we find *A. robustus* fossils only in caves, where their remains accumulated for





***A. robustus* (male)**
2 to 1 million years ago



***A. robustus* (female)**
2 to 1 million years ago



***A. boisei* (female)**
2.3 to 1 million years ago



Homo sapiens sapiens
125,000 years ago to present

The male jaw and female skull found at Drimolen are shown here (missing pieces in blue), as is the most complete female skull yet found of *A. boisei,* a similar hominid from East Africa. It is unknown whether these species shared a common immediate ancestor.

ADAPTING TO A DRIER LAND

About 2.5 million years ago southern Africa was drying. Although some trees remained near watercourses, the forest largely turned into grassland, and animals moved, adapted, or died out. For *A. robustus*, shown here defending its territory, this meant living on tough foods like roots, tubers, and seeds instead of softer foods like fruit. The hominids developed large jaws and molars to handle this fare; males had such huge jaws that their muscles were attached to bony crests on top of their skulls (illustration, left). Females did not have these crests, and their jaws and teeth were as much as a third smaller than males'—a greater difference than we had previously seen. These finds—especially the female skull—give us a much better picture of the species.

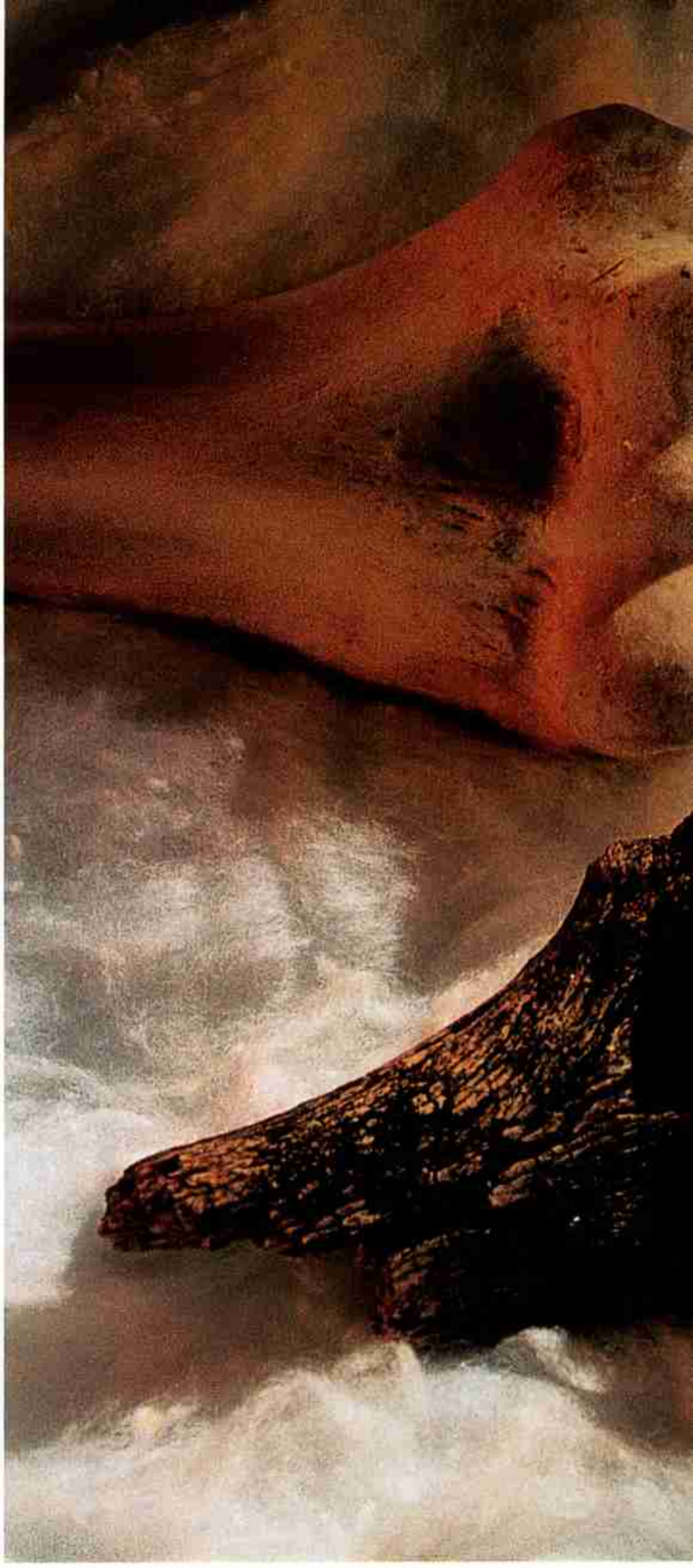
TWO SPECIES, MORE BONES, MORE QUESTIONS

What's better than finding one hominid species in a dig site? If you say, "Finding two hominid species," we could have an interesting conversation. We did find two species at Drimolen—*A. robustus* and an undetermined species of *Homo* that lived at the same time—and it's both a blessing and a curse. Pictured at right are hominid bones we've discovered plus a modern human humerus, at upper left, for size comparison. Some specimens—like the adult humerus at bottom left and the infant humerus next to it—we can't pin to either species. If we can't tell the bones apart, how do we know we've found two species? Simple: teeth. They're like a species' fingerprints, often giving us an unmistakable identification where bones do not. And teeth, like the *A. robustus* baby teeth at far right, are plentiful. Tooth enamel is the most durable biological substance known, so teeth are more likely than bones to survive a million-plus-year burial—in fact, most of the world's hominid fossils are teeth.

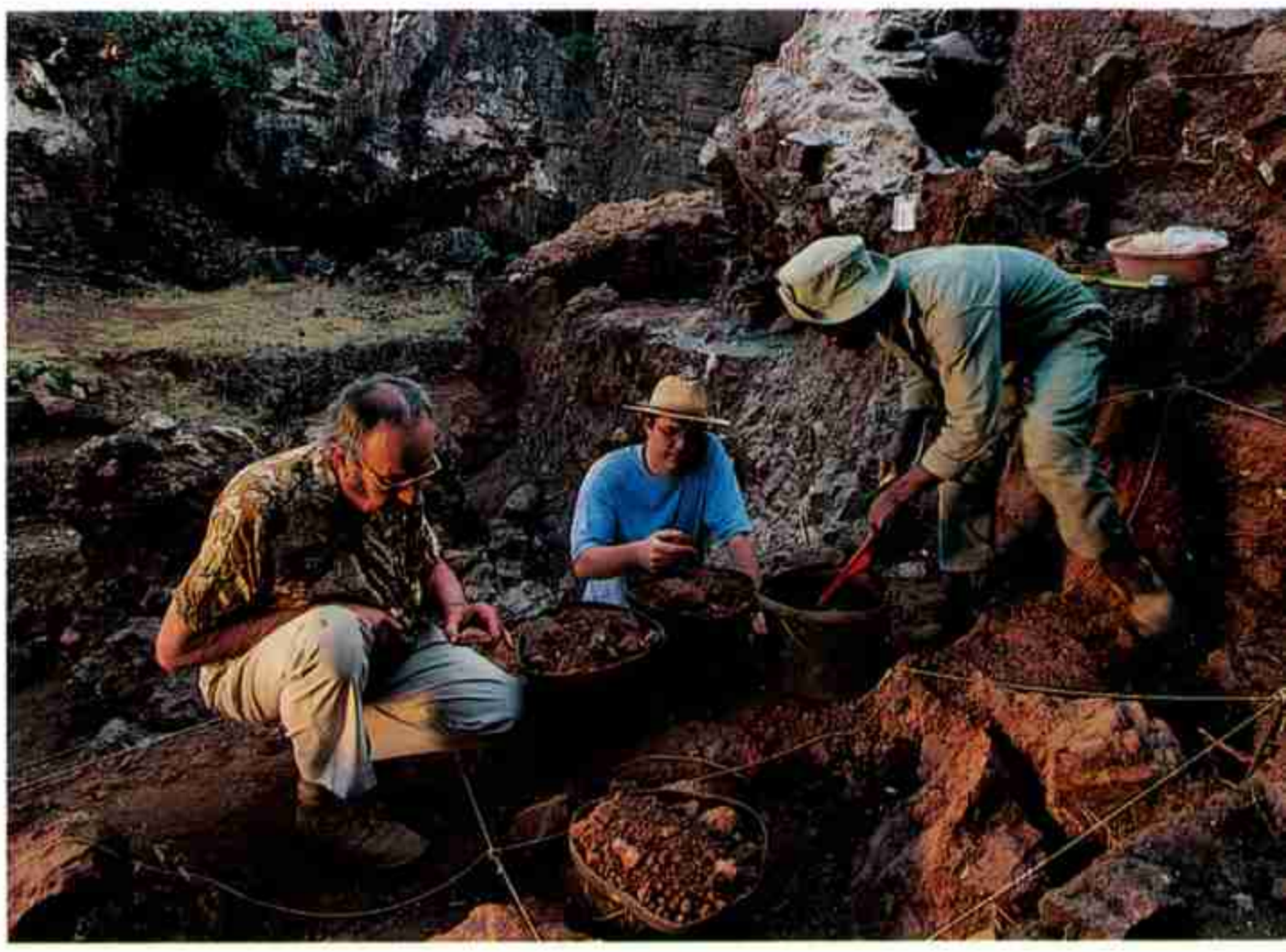
So the handful of *Homo* teeth we've found at Drimolen have made it impossible to definitively identify many of our bones as *A. robustus*. When bones and teeth are found together, though, we infer that they were likely from the same individual. That's the case with the three *A. robustus* fossils at the top of the photo (two arm bones and a jaw) and the *Homo* fossils at

RESEARCH PROJECT

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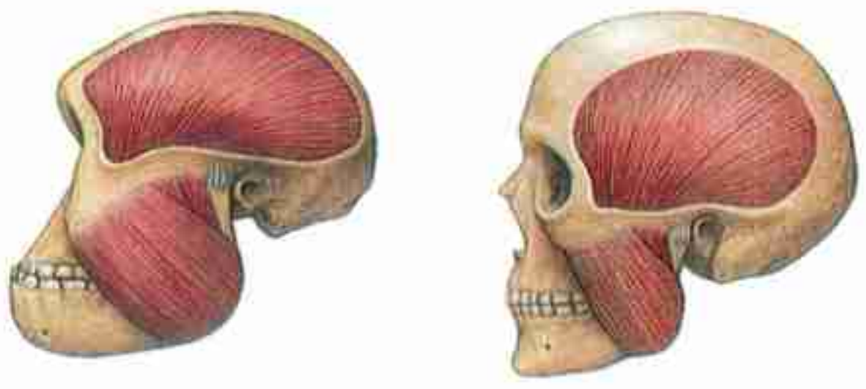


ANDRÉ W. KEYSER retired early from the Geological Survey of South Africa to excavate Drimolen. KENNETH GARRETT's most recent assignment was "Valley of the Mummies" in October 1999. MAURICIO ANTÓN's artwork appears in "The Human-Cat Connection" in June 1997.

bottom right (also two arm bones and a jaw).

We even found some sharpened bone points (opposite, far left), most likely from bones used as digging tools. We believe *A. robustus* used bone tools and probably used these particular ones, but again, because *Homo* fossils were found here, it's impossible to be certain. We'd practically have to find a tool clenched between teeth to know for sure who used it.

Despite the questions, the more we find the more we stand to learn—about how *A. robustus* lived, how the species coexisted with *Homo,* and why it became extinct as *Homo* evolved. I'll be long gone before Drimolen is thoroughly excavated and studied, but many answers—and no doubt more questions—will come from this site. □



Though *A. robustus* (left) had the same number of teeth as modern humans—32—its much larger molars and jaws required massive muscles that attached to the top of its skull.

For more on South African digs go to *www.nationalgeographic.com/outpost.* Also see the Society's book *In the Footsteps of Eve,* coming out in June.

Drinking nectar from the acacia tree that shelters their colony, *Pseudomyrmex* ants pay

Ants and Plants

Tree Fortresses



Article and photographs by
MARK W. MOFFETT

rent by fending off leaf-eating enemies—a tree-size symbiosis designed for mutual survival.

In Costa Rica a *Pseudomyrmex* ant rips apart a vine that grips leaves of an acacia tree (right) where the ant's colony resides. If left to grow, vines could weigh down, shade, and possibly kill the tree. In West Africa a *Crematogaster* ant smashes butterfly eggs on a *Barteria* leaf (below). Hatching caterpillars would eat the leaves of this tree, the ant's home. In both cases, specialized ants—often of species living nowhere else—tend trees day and night with the diligence of obsessive gardeners.



Ants and plants have developed many curious relationships, some positive, some negative. Extreme examples occur with tropical plants called myrmecophytes, or "ant plants," which provide their insect guests with housing and often food. Many of these ant plants are vines or other types of treetop vegetation, but in the examples shown here, the hosts are the trees and shrubs themselves. I have explored, documented, and marveled at whole groves of ant trees in Brazil and Borneo, in areas where biting and stinging ants are the true lords of the jungle.

Often the ants' behaviors can be interpreted as self-serving: The worker killing eggs gets a meal; the one gnawing vines destroys a route that might be used by invading enemies. In other cases workers defend particular parts of the plant that affect their tree's long-term health and reproductive ability with no apparent immediate benefits to the ants.

Either way the interaction tends to be beneficial in the long term to both ant and plant—a symbiotic relationship that ecologists call mutualism. But as I will show you, sometimes this relationship breaks down, as when parasitic ants seize control of a tree.

Ecologist MARK MOFFETT contributed the two earlier installments of this "Ants and Plants" series: "A Profitable Partnership" (February 1999), an overview of these curious relationships, and "Friends and Foes" (May 1999), which focused on other species of ant plants.



KILL OR BE KILLED

Dwelling within hollow branches of the tree *Cordia nodosa,* the orange-colored workers of an *Allomerus* colony dismember the corpses of their enemies (bottom right). *Allomerus* is a parasite: It sterilizes its host by dismantling the tree's flowers (below). With its energy diverted from reproduction, the tree grows larger, thereby providing more living space for the colony. Other ants are mutualists: They encourage reproduction of their habitat by protecting the host's flowers.

Studying *Cordia* and other ant plants in Peru, biologist Doug Yu plucks vicious *Pseudomyrmex* ants from a *Triplaris* tree, its base cleared of vegetation by the ants (bottom left).

In West Africa *Leonardoxa africana* trees harbor either *Petalomyrmex phylax,* a helpful ant that kills leaf-eating insects, or *Cataulacus mckeyi,* a parasite. The "good" ants keep out competitors by shaping their nest entrances as narrow slits, which a round-bodied *Cataulacus* queen cannot enter (right).









FIT FOR A QUEEN

This *Azteca* queen was lucky: She found a hollow, unoccupied chamber inside a *Cordia* tree branch (sliced open by the photographer) big enough to accommodate her distended abdomen as well as her milky white brood. The tree also provides a defensive shield: Stem hairs are spaced wide enough to permit future workers to maneuver, yet narrow enough to thwart larger enemy ants.



HOME SWEET HOME

Chiseling an entry into the hollow stem of a *Cecropia* sapling, a *Pachycondyla* queen (below) seeks a place to start a new colony. *Cecropia* trees are common along rivers and near human settlements in tropical America; *Macaranga* trees are an ecological equivalent in Old World tropics. Ant workers, lured by sugary rewards along the margins of young *Macaranga* leaves (bottom left), patrol and protect this foliage, which is tasty—and vulnerable—to beetles and other herbivores.

Macaranga also furnish their ant guardians with main courses, stashed in larders beneath purple stipules (near right). Inside, pearly globules of fat glisten, tasty as mini-marshmallows (far right). Like peas in a pod, *Pheidole* ants live in tiny pockets on the leaves of *Maieta* shrubs (bottom right). One chamber usually serves as a nursery for ants and their brood, while the adjoining one contains ant refuse—a compost heap from which the shrub might absorb nutrients.











POINTED CONFLICT

Thorns of the African *Acacia drepanolobium* have swollen bases occupied by any of four ant species. One of them, the mutualist *Crematogaster mimosae* (right), vigorously guards the tree's leaflets. By contrast, an acacia occupied by parasitic *Tetraponera* ants (below) looks bare and sickly. While *Crematogaster* ants attack anything eating their tree, their feistiness fails to deter patas monkeys, which enjoy protein-rich meals by biting open the thorns and savoring the pungent mass of ants within (bottom). After a monkey gulps a mouthful of ants, it dashes to the next tree before ants at the first one begin to swarm.











CARROT ON A STICK

Besides supplying adult ants with a sweet nectar, American acacia trees offer carrot-like growths at the tips of their leaflets (facing page)—a specialized "baby food." *Pseudomyrmex* workers deliver this nutritious fare to their nest chambers (top) for the growing larvae to devour (middle). Even when ants are absent, acacias continue to produce the growths. A Costa Rican *Piper* shrub, though, is more frugal. It secretes sticky white food globules only after the favored ant species moves in (bottom), then stops producing them if the colony dies out. All in return for some ant-size tender loving care. □



Tall Order

CAPE HATTERAS LIGHTHOUSE MAKES TRACKS

Slow as a sea turtle on land, the 208-foot-high Cape Hatteras Lighthouse was rolled to its new home, a half mile from the beach, at a top speed of one foot a minute. Survivor of a major earthquake and some 40 hurricanes, the 130-year-old beacon not only arrived without a crack—it got there two weeks early.

BY ANGUS PHILLIPS

PHOTOGRAPHS BY KAREN KASMAUSKI



THE NAUTICAL CHART minces no words. "Hydrography is not charted on Diamond Shoals due to the changeable nature of the area. Navigation . . . is extremely hazardous to all types of craft." Yet here we are in a cockleshell of a fishing boat, under the loom of perhaps America's most famous lighthouse, half a mile off the feared headland in the grip of crashing waves and shifting shoals that gave this place its grim nickname, Graveyard of the Atlantic.

"Cast there," says John Robert Hooper, who pilots his 350-pound, homemade skiff through the foam standing up, revving the outboard to smash through breaking waves. "See if you can hook that spinner shark."

To the west, rising above the surf, stands black-and-white, candy-striped Cape Hatteras Lighthouse, at 208 feet the world's tallest brick lighthouse and at 130 years old a treasured symbol of America's seagoing glory days.

Hooper is unimpressed. "It's in the wrong place," he grumps, readying a diatribe. But action intervenes when a false albacore whacks my lure. The battle is on.

We caught our limit of Spanish mackerel that August evening, probing waters that have claimed hundreds of lives and scores of craft over the years. It was months before the millennium's turn and weeks after completion of one of the engineering triumphs of the 20th century. Cape Hatteras Lighthouse, 9.6 million pounds of granite, brick, marble, iron, brass, and bronze, was resettled, a half mile from where it had stood since just after the Civil War.

The relentless surf that had threatened to topple it was now 1,600 feet away. The lighthouse was tucked away in scrub oak and pine where it should last a century more before the hungry sea comes knocking again.

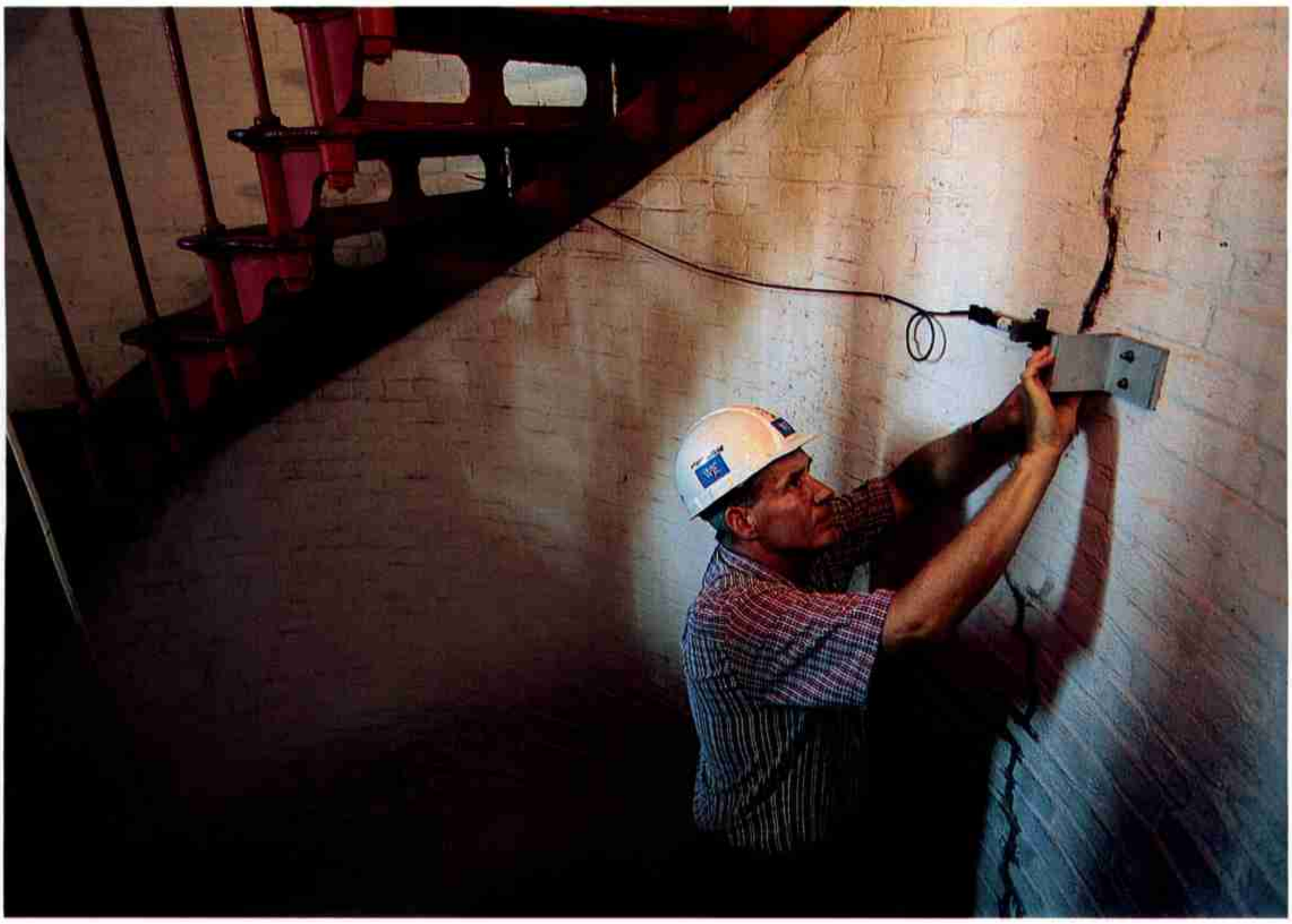
Hooper, whose Lighthouse View Motel sits close by the old site, wishes along with many of his neighbors that the National Park Service had continued a decades-old policy of protecting the beacon by reinforcing the diminishing beach in front of it with groins and sandbags and sand replacement, which might have protected a number of valuable man-made structures at the exposed tip of Carolina's sandy barrier islands.

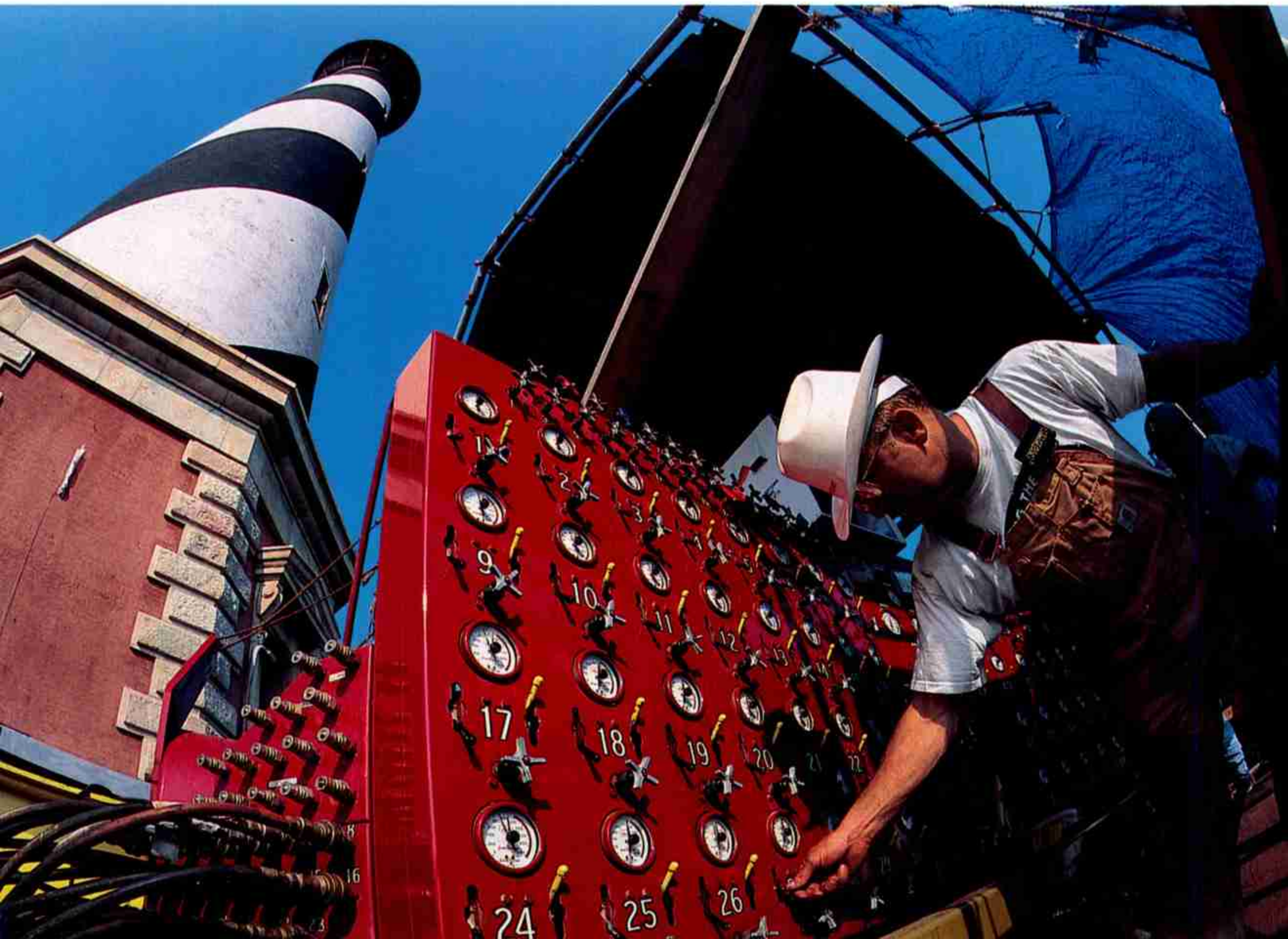
But NPS instead followed ten-year-old recommendations of the National Academy of Sciences to pack up the tower and shuttle it down a track. Twenty-three days and 11.8 million dollars later, to the amazement of many, the job was well and truly done.



ON THE MOVE, *the epic lighthouse journey drew thousands of spectators, who lined the specially made runway. Most of the strip will be replanted. Existing cracks in the tower, probably caused by thermal expansion in the late 1800s, were carefully monitored during the move (above right). No growth in the cracks was found. As hydraulic rams gingerly pushed the structure along, a technician checked a hundred jacks placed under the lighthouse to keep it level (right).*

ANGUS PHILLIPS, an avid fisherman and sailor, writes about the outdoors for the *Washington Post.* His last GEOGRAPHIC story was *"The Whitbread—Race Into Danger,"* in the May 1998 issue. KAREN KASMAUSKI has documented seashores from Okinawa to the Sea Islands in her many assignments for the magazine.





How to Save a Lighthouse

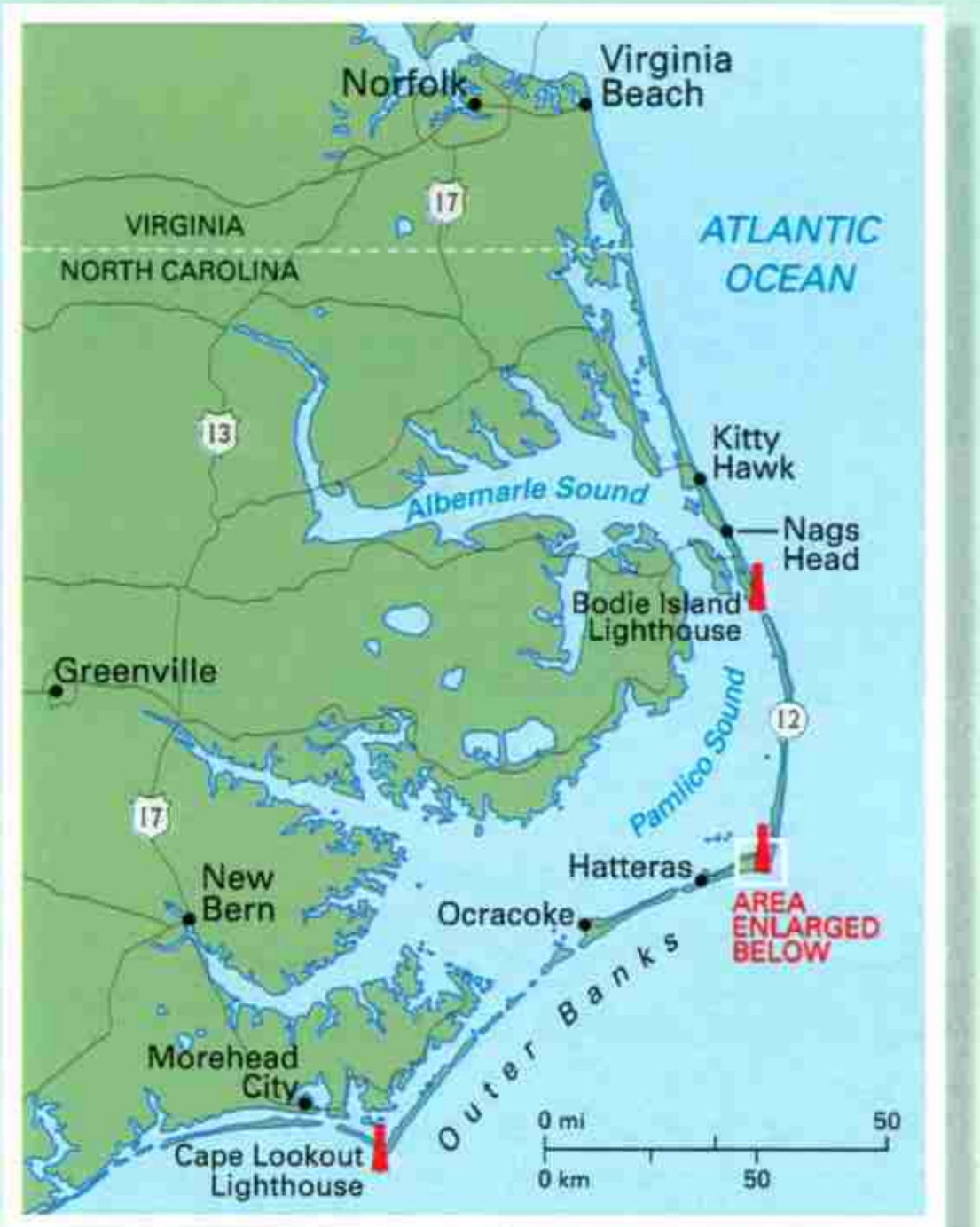
Hatteras Lighthouse was doomed. The Civil War–era North Carolina landmark was perhaps one major hurricane from disaster. To move it to safety, the National Park Service adopted a technique that had been used to rescue other lighthouses, although never on such a large scale. The lighthouse was first severed from its foundation by a heavy-duty, diamond wire saw, then raised on hydraulic jacks. A support frame of steel beams was slid underneath. Lowered onto seven steel travel beams fitted with roller dollies, the lighthouse and frame were ready to roll. Pushing against the steel frame, five hydraulic rams gently nudged the lighthouse toward its new location. As the assembly neared the end of a length of travel beam, previously used beams were placed ahead atop a steel mat.





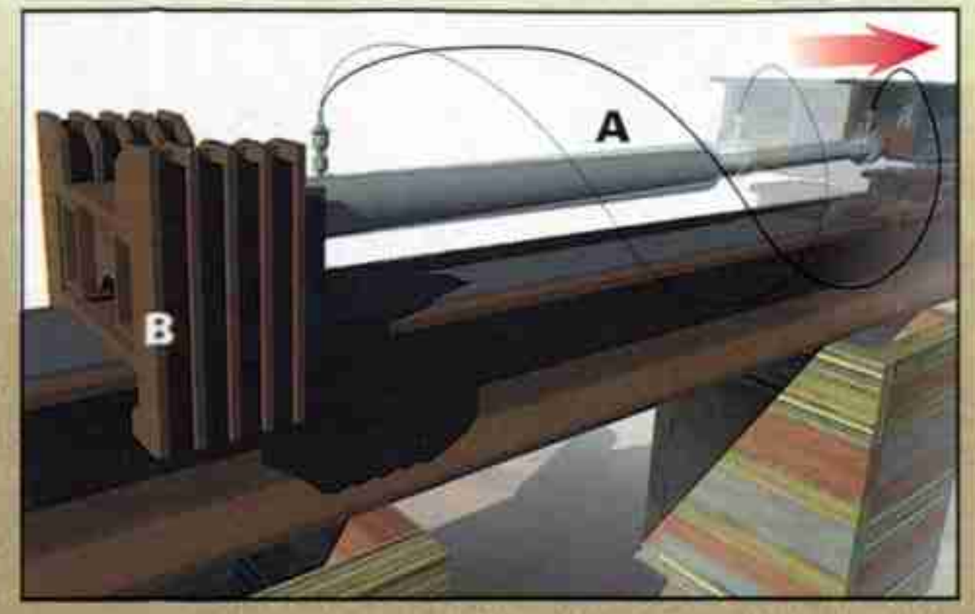
SHIFTING SHORELINES

Hatteras Island was moving southwest, but it was not taking its famous lighthouse along for the ride. At the time this lighthouse was built, the sea lay 1,800 feet distant. Now, having carved away the old shoreline and extended the island to the south (map below right), the Atlantic Ocean crashed barely 120 feet from the base. For decades park officials struggled to hold back the sea with sand replacement and barriers. They even tried artificial seaweed to slow erosion, with little success. Finally, a commission decreed that the only way to save the structure was to help it play catch-up with the shifting sands beneath it.





The lighthouse now stands 2,900 feet from its original site. Its light can be seen 24 nautical miles away.

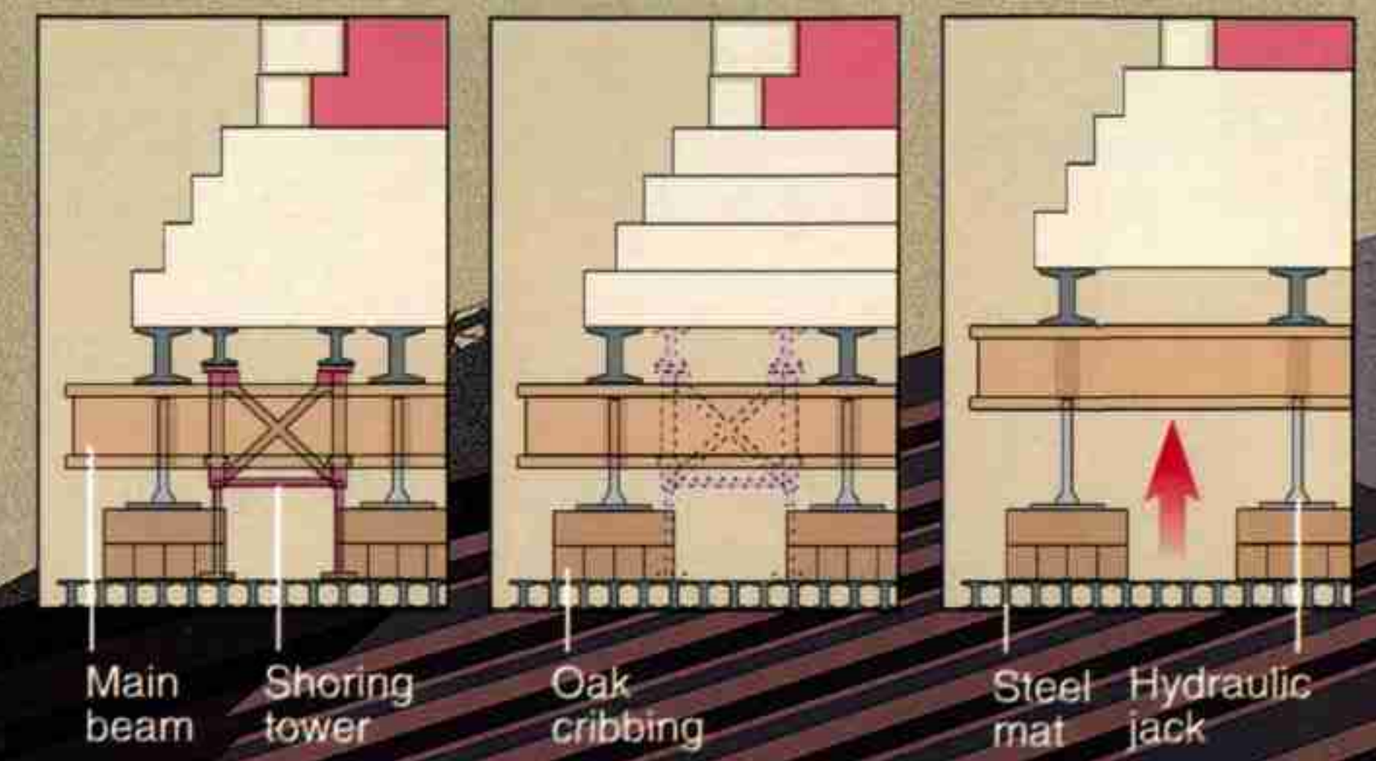


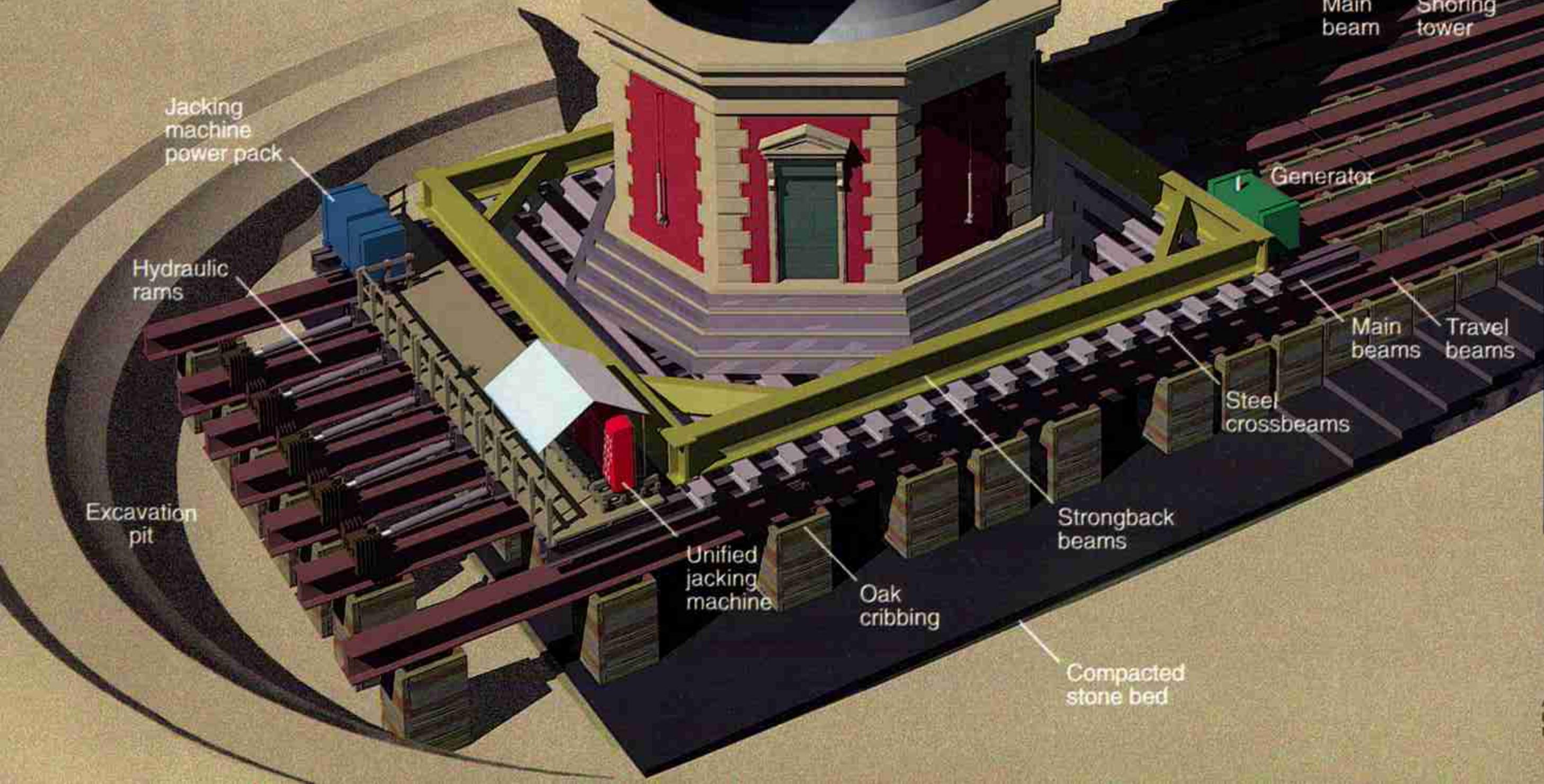
THE BIG PUSH

It takes a lot of muscle to shove a 4,800-ton lighthouse uphill, and in Hatteras's case the job was done by five hydraulic rams (A), turned on their sides. Pushing against hydraulic clamps (B) and the support frame, the rams slowly moved the assembly in five-foot intervals.

LIFTING A 20-STORY CANDLESTICK

Before the lighthouse could be set down on its travel beams, it had to be lifted six feet. Workers excavated to remove the stone-and-wood foundation while simultaneously replacing it with shoring towers. These, in turn, were replaced with a hundred hydraulic jacks—each lifting about 50 tons—resting on oak cribbing.







99 & 44/100% SLIPPERY

Adapting the age-old carpenter's trick of lubricating wood screws with soap, workers greased the travel beams ahead of the moving monolith with bars of Ivory soap.

ART BY WM PITZER. SOURCES: INTERNATIONAL CHIMNEY CORP.; EXPERT HOUSEMOVERS INC.; WISS, JANNEY, EISTNER ASSOCIATES; NATIONAL PARK SERVICE; *CHARLOTTE OBSERVER*

Indeed, in the days after the move was completed, two weeks ahead of schedule and without a hitch, the work site around the light's new home resembled the locker room of a World Cup winner, with burly construction men sporting grins as wide as their unique ten-gallon hard hats.

No smile was wider than that of 78-year-old Pete Friesen, who designed the unified jacking system—a hundred infinitely adjustable hydraulic supports linked through a computer—that kept the tower upright as it rumbled 2,900 feet down a steel track over beach sand, propelled by five huge hydraulic rams.

Movers from International Chimney Corporation of Buffalo, New York, and Expert Housemovers of Sharptown, Maryland, nudged the tower on steel rollers lubricated with soap. It all went so smoothly that Jerry Stockbridge, inside the structure monitoring a computer for signs of tilt, had to step outside to see if the tower was actually under way. When it was over on July 9, the national historic landmark had found a new home, yet no one could discern even a fresh crack in the mortar.



WHY MOVE Cape Hatteras Lighthouse at all? Many asked. It is no longer an important aid to navigation, having been overtaken by technology including global positioning satellites, loran towers, and a Texas tower 13 miles offshore to mark the tip of the lethal shoals. No seaman needs a brick lighthouse on the beach to figure out where he is anymore. Rob Bolling, the Park Service's local historian, expects the Coast Guard to decommission the light as an aid to navigation within a few years, at which point it will be only a museum and national landmark. The last full-time keeper, Unaka Jennette, left in 1936. The lighthouse was dark for 14 years after his departure.

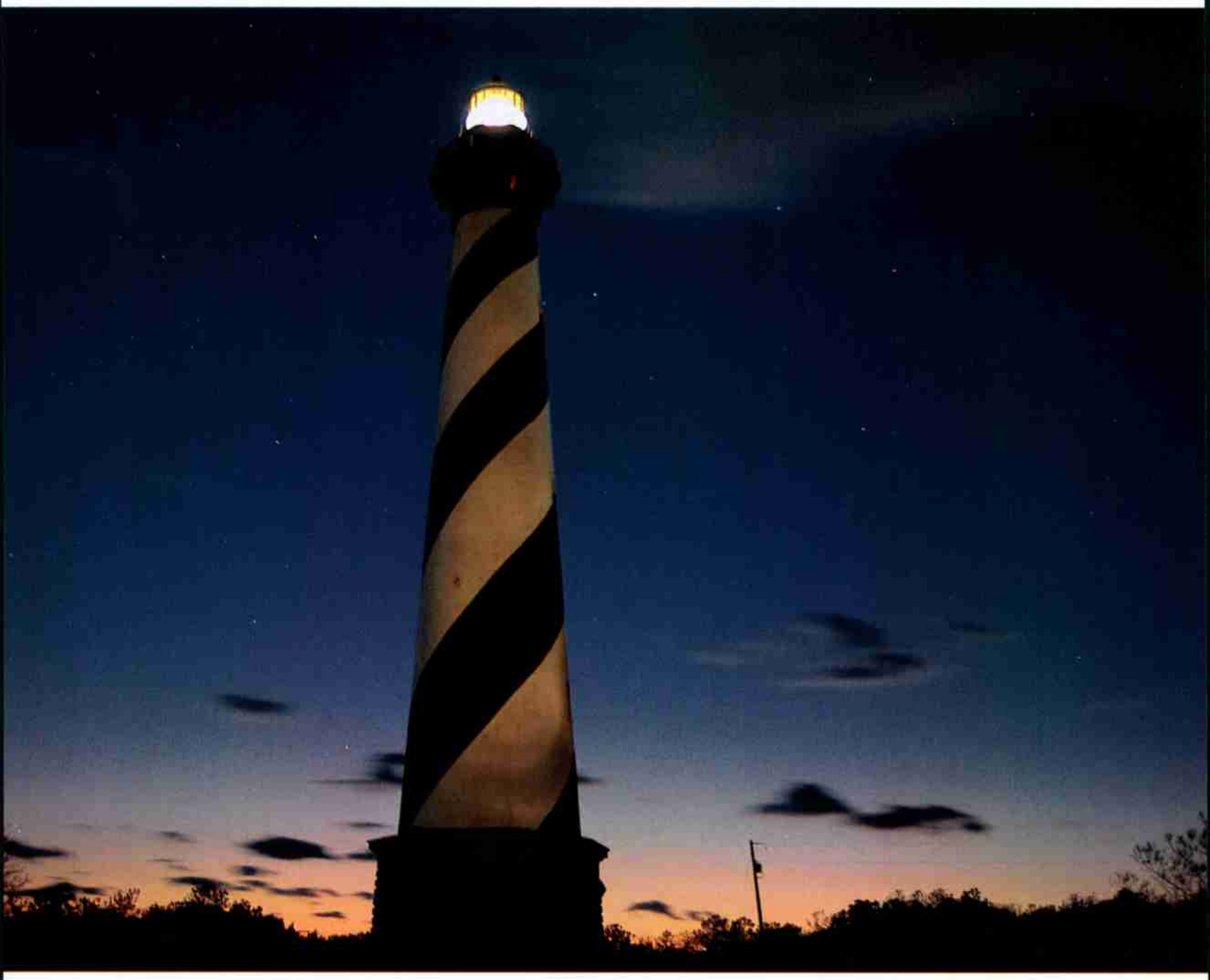
To understand the significance of this light, says historian David Stick of Kitty Hawk, one must look back in time to the 1800s, before the age of railroads and highways, when ships under sail carrying people and goods battled in conditions fair and foul to weather Hatteras, the most fearsome cape in the East, where hurricanes spin up suddenly, winter northeasters turn the sea to spume, and shoals stretch seaward like moving underwater booby traps.

At Hatteras the Gulf Stream kisses the tip of Diamond Shoals as it runs north up the coast, then turns toward Europe, rushing along at up to four miles an hour. With prevailing winds in their faces, southbound ships hopscotched along the coast to Hatteras, taking a push from remnants of the inshore Labrador Current, then waited, sometimes days, for a wind shift so they could buck the Gulf Stream and round the shoals.

"The old-timers 50 years ago told me they'd seen up to 150 sails out there, tacking and waiting for the wind to shift," said Stick. "And when it did, it could do so with a vengeance."

Captains waiting took comfort in the wink of Hatteras Light at night, or a glimpse in daytime of its famous barber-pole stripes, which distinguish it from the horizontal stripes of Bodie Island Lighthouse to the north or the black-and-white diamond squares of Cape Lookout Lighthouse to the south. Hatteras told skippers where they were in relation to Diamond Shoals, where sandbanks lie just below the surface miles offshore and bad weather sends the sea into towering plumes.

Stick once documented some 600 ships lost since colonial times along the Outer Banks. Since then, he said, other reasonable estimates put the total above 1,000. Wrecks were common enough for the U.S. Lifesaving



SHINING ANEW, *the Hatteras Light resumes the 7.5-second-interval rotation that distinguishes it from other beacons. And although it now stands farther inland, the light's slightly higher elevation makes it visible just as far out to sea.*

Service to establish stations every six to seven miles along the Outer Banks in the late 1800s, from which "surfmen" patrolled daily, looking for stranded ships and sailors to rescue, as well as the washed-up bones of newly shattered craft.

Just after the Civil War a gifted New England construction foreman named Dexter Stetson was sent to oversee construction of the most important lighthouse in America. "You can't build a brick structure on sand, of course," said Stick. "But he did!"

And did it well. One hundred thirty years later, double-walled Hatteras Lighthouse stands in a new home, casting its anachronistic warning over still perilous waters. Folks travel thousands of miles to visit; in the six seasons before it was closed for the move, more than a million people climbed the 257 steps to the balcony, according to Park Service figures.

On Memorial Day, 2000, refurbished and repositioned Hatteras Light opens to a new millennium's admirers. Whether they come by land, as most will, or view it from the foam of Diamond Shoals, as few dare, they will gaze upon an American original. □

Learn more about the painstaking relocation of the Cape Hatteras Lighthouse at *www.ngnews.com/hatteras.*

Mount St. Helens

NATURE ON FAST FORWARD

With 500 times the force of the Hiroshima blast, Mount St. Helens erupted 20 years ago this month. Today life is returning to the devastated slopes of this youngest and most active volcano in the Pacific Northwest, which has repeated its cycle of destruction and renewal again and again.



8:32 Sunday morning, May 18, 1980: "Vancouver!

More than a mile wide, the crater left by the 1980 eruption draws 600,000 visitors a year to a ridge named for geologist David Johnston. Stationed here, five miles from the summit, he was killed by the volcanic blast. The accompanying landslide was the largest ever recorded.

Vancouver! This is it." — David Johnston



Foxgloves inflame a hill that was smothered in ash, while trees make a comeback nearby. Here in the 110,000-acre National Volcanic Monument, created by the U.S. Congress in 1982, nature has been left alone to reclaim land laid waste by heat and debris.

BY ROWE FINDLEY • PHOTOGRAPHS BY JIM RICHARDSON

WE LIVE BETWEEN the fire and the ice. That thought comes to mind as I hover in a helicopter above the crater of Mount St. Helens, the source of unquenchable fire two decades ago. On March 27, 1980, this snow-white 9,677-foot volcano in the Cascade Range began a series of eruptions that blackened the Fuji-like peak and riveted world attention. On May 18 it self-destructed, setting off the biggest landslide in recorded history and losing 1,300 feet off its crown—the worst such disaster ever visited on the contiguous 48 states. Fifty-seven people died, and birds and animals large and small in unknowable multitudes. Forests and meadows and mountain streams were transformed into an ash-gray wasteland—some 230 square miles of it. That ash brought darkness at noon to central and eastern Washington and ultimately went around the world.

I was a stunned eyewitness to those events, which now seem like a former life. Before the May 18 eruption, I shared an innocent excitement that greeted each seismic burp and yawn of the restive volcano. Afterward came haunting awareness that I had not only seen an idyllic world vanish but had also lost valued friends. A persistent sadness bore down on me. It gradually relented but years later could reassert itself without warning. Despite reason, I came to see the mountain as evil.

Now the crater looks almost benign—quiet and tame under tons of snow and ice that even in summer burden its flanks and reside in the crater itself. Sculpting winds have salted the snow gray with swirling ash and rippled it like the sea. Some snow even clings here and there to the jumbled lava dome where molten rock surfaced as late as 1986. In the late summer of 1980 the dome towered some 200 feet, and I could stroll around it. Destroying and rebuilding itself more than once, it now measures just under 900 feet high and more than three-fifths of a mile wide, almost reaching the east and west crater walls. Geologists who monitor it ride helicopters that land gingerly on the dome itself. They keep an eye out for plummeting pieces of the wall that stir rising clouds of ash, which amateur observers often mistake for volcanic activity.

Stretching away to north and east and west lies the deadly fan of destruction that reached as far as 15 miles from the volcano. This area—more than three times the size of the District of Columbia—was blowtorched by fiery gases after the crater's north wall collapsed. From my aerial vantage I still see the bleaching trunks of giant conifers laid down in a radial pattern by the expanding wave of the blast.

But I also see many signs of resurgent life—extensive greening slopes in the far distance and major plant colonies closer at hand. Even on that most sterile of landscapes, the so-called Pumice Plain that slopes down from the failed north crater wall, an intent inspection reveals brave little vegetative beachheads. In the summer of 1980 this entire area stretched out like a moonscape, for all appearances devoid of life—a blank slate, passive and waiting. Now I see it coming to life again. As my helicopter ride ends, I recall a prophecy by scientists that

ROWE FINDLEY, who covered the 1980 eruption of Mount St. Helens, is a former GEOGRAPHIC assistant editor. Freelancer JIM RICHARDSON, a native of Kansas, photographed "Cascadia: Living on Fire" (May 1998), about the geologic history of the Pacific Northwest.

The deadly fan of destruction reached as far as 15

the post-eruption void would become a crucible of creation. Now I am privileged to see that prophecy being fulfilled.

FOR ME, A CRITICAL TEST of this re-creative process would be the hummocks, a random maze of mounds in the North Fork Toutle River Valley. They were deposited by the destructive debris avalanche caused by the collapse of the summit and north flank of the volcano. That lifeless landscape is fixed in my memory as among the most extreme expressions of desolation. It's a mix of ash, boulders, and landslide debris laid down in a few awesome moments, then covered by scorching pyroclastic flows. Today a footpath winds through this tortured landscape. I join a walking tour of that trail, led by two scientists who have long studied the volcano's impact.

"When the eruption is over, it's not over—the consequences go on." That's Peter Frenzen's way of introducing our walk through an area caught up in the consequences. Peter is the staff scientist for the U.S. Forest Service's Mount St. Helens National Volcanic Monument. Sharing the field trip's guide duties today is Jerry Franklin of the University of Washington in Seattle, author and researcher on national forests. In contrast to my tendency to personify the mountain, they take the objective view of science, and they are excited by the chance to study such a large-scale "legacy of natural destruction," as Jerry describes it. I have tagged on to a large group of UW students and ecological journalists, and because this is such a fragile study area, we must not take even one step off the trail.

Soon we're walking through one of the early creations—a wildflower garden. It's a scattered mix of lupine, Indian paintbrush, pearly everlasting, and fireweed, anchored cheerfully in coarse gray rock. Willow and alder trees reach skyward, the latter sometimes tall enough to shade our twisting path. The roots and decaying leaves and stems of this vegetative vanguard provide organic material needed to convert volcanic grit into sustaining soil. Sparkling brooks and ponds shelter frogs and water beetles. Underfoot, tiny toads gallivant in such profusion that the ground itself seems to be hopping. Tufts of grasses hoist swaying seed heads in a fitful breeze.

The plants and trees we see are opportunists, inured to extremes of season and altitude, equipped to stake claims in this harsh void. Lupines play a key role; bacteria on their roots release nitrogen, necessary to all plants. Alders form winged seeds that ride the wind. In contrast to the killer gales of eruption, lesser winds disperse seeds and soil—though not always gently. "Winter winds here can blow cantaloupes and watermelons," Peter notes. It's a delivery vehicle to give near-sterile areas what they lack. As Jerry Franklin puts it, "Soils in the Cascades fall from the sky."

Birds and animals help the process by eating, transporting, and depositing seeds in their droppings. Burrowing gophers penetrate the ash blanket and bring former topsoil topside once more. Droppings along the trail tell us that elk have visited here. In contrast to small creatures, big animals had no place to hide from the eruption, and the elk—nearly 2,000 of them—died, in addition to a small herd of mountain goats and thousands of deer. By last year only a few goats had been seen, but deer were plentiful, and elk had rebuilt their numbers. However, as Peter tells us, the previous winter's snows made them vulnerable to starvation, disease, and predators. "It was a bad year to be an elk but a good year to be a coyote."

Those managing the national monument have made a decision to let nature take its course here, delighting scientists, who have an unparalleled opportunity to watch and learn. It is a miniature fast-forward version of what happened over vast time frames of our planet's infancy, from primordial soup to the first wind-borne seeds. How do life-forms come back from ground zero? With Peter Frenzen's coordination, hundreds of test plots are now being monitored by scores of researchers tracing cycles of regeneration. What will we learn? "For one thing, it will teach us how to manage forests better," says Jerry Franklin.

The 1980 eruption triggered an emergency course in forest management for Weyerhaeuser. Trees on more than 68,000 acres of its Mount St. Helens Tree Farm were destroyed or felled and lay in the cooling ash, vulnerable to

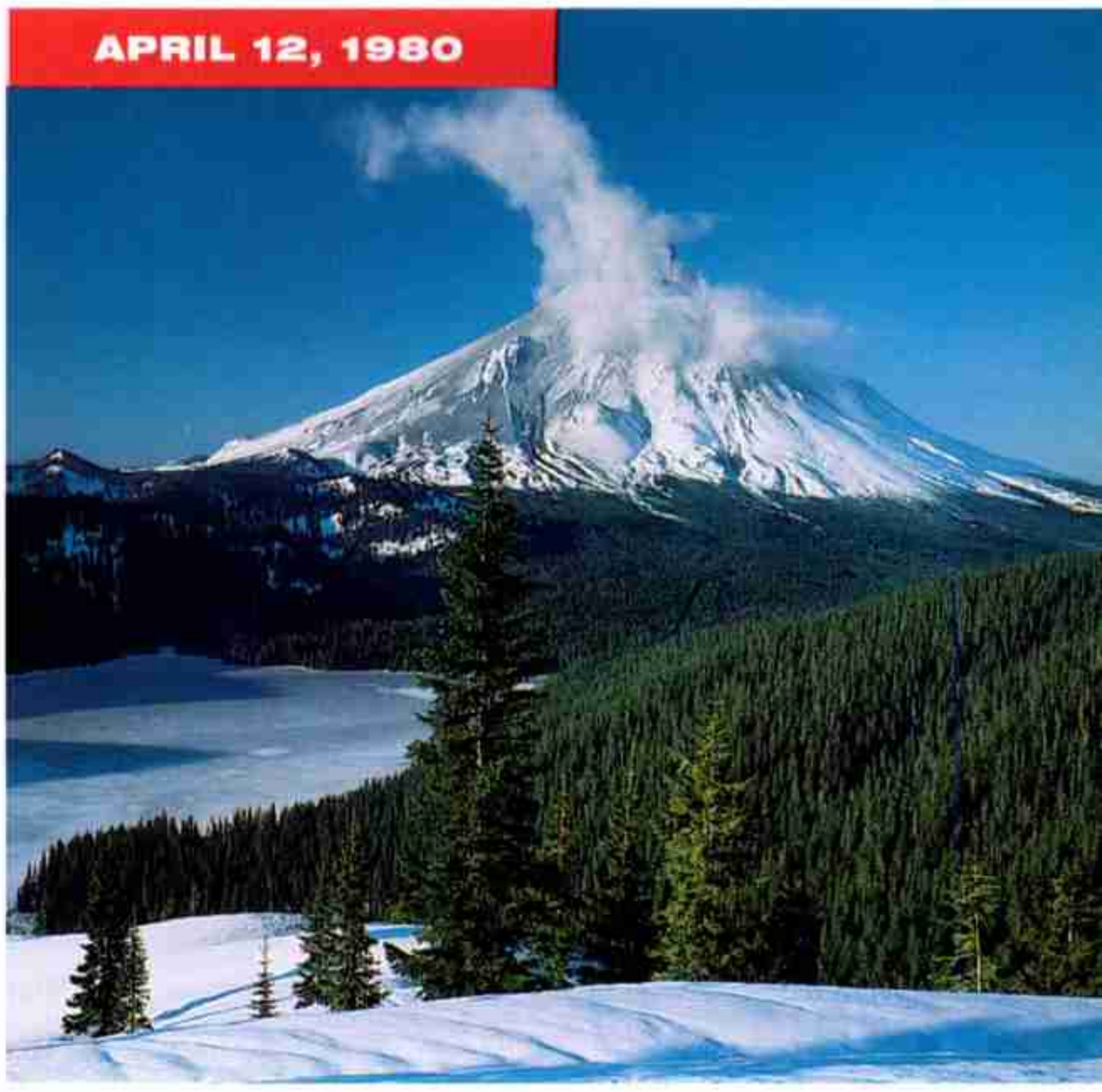
miles from the volcano.

rot or insects. The salvage and tree-planting operation had the urgency of battle, as remembered by Dick Ford, who was there. He now directs the company's Forest Learning Center on State Route 504, created to explain the blast's effects on the forest to visitors. "We had to act fast," he said. "We had lost three logging camps and many miles of roads and railroads." A thousand workers converged on the area. Endless parades of logging trucks carried hundreds of loads a day to mills in the vicinity, which cut enough lumber to build 85,000 three-bedroom homes. Replanting began the following winter, with care to get seedling roots into soil beneath the ash. "Some now top 55 feet," Dick said. "We expect our first cut in 2024."

THE ERUPTION also disrupted human lives. Those who lost loved ones wrestled grief and futility. How could the whole world change so suddenly? Among those trying to sort it all out was Donna Parker. On that momentous May 18 she had stood outside her home in Canby, Oregon, near Portland, and watched the blue-black pillar of ash roil over Mount St. Helens, 70 miles away. The plume expanded ominously into what had been a cloudless Sunday morning. "I walked up the hill for a better view," Donna recalled, "and I thought, I'm so thankful we don't have anybody up there."

But later came word that her brother William P. Parker and his wife, Jeanne, were missing. An air search located the truck and the couple on an ash-covered spur of Coldwater Ridge. "It's the picture on pages 32 and 33 of your January 1981 GEOGRAPHIC," Donna said. A roll of film from inside the truck miraculously printed. "It shows my brother sitting on the stump in the foreground. It was taken the day before he died."

Donna soon realized she was not at peace. She decided to place a white wooden cross where William and Jeanne had died. Others had perished in the area, and some were longtime friends, so her list of crosses grew—to 12. "I tried to visit the crosses on the eruption anniversary, and I'd leave a flower at each one." For a while she also organized picnics for survivors. Some of them joined her visits to



A month before the blast, a plume of steam hiding a perfectly conical peak hints at the fire within. Rising magma pushed against the north flank until it triggered a landslide that took 1,300 feet off the summit (below). The subsequent explosion unleashed a searing cloud of gases, rocks, and ash that flattened 230 square miles of forest. Yet spring snow protected saplings, seeds, and hibernating animals and jump-started the process of regrowth. "If this had happened in August, everything would have been lunar for much longer," says David Wood, a plant ecologist at California State University, Chico.



BOTH BY JOHN MARSHALL

Mount St. Helens

MILLENNIA OF CONSTRUCTION, DECADES OF RENEWAL

"All of us were surprised at the rate at which this landscape was colonized again," says ecologist David Wood. "We were thinking, Gosh, how long is it going to be before *anything* comes back here?" Within just a few years scientists found flora and fauna pioneering in the niches created by the eruption's various geologic disturbances. By now resettlement is well under way (right). Nature has already fought back from catastrophe many times here. Born of the collision between the Juan de Fuca and North American plates (bottom), the volcano we see today was built during the past 4,000 years (below).



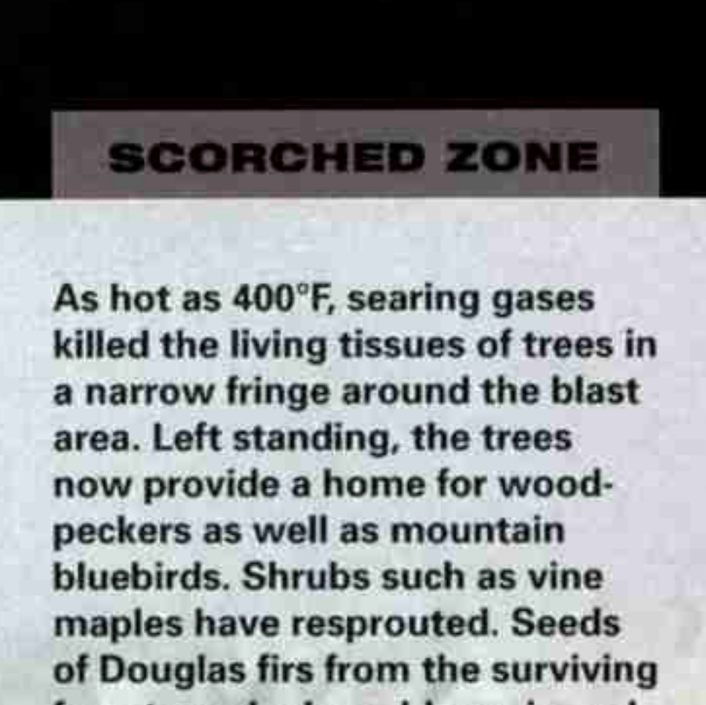
SOURCE: USGS; GRAPH BY CAROLYN P. SUMMERVILLE, NGS

Explosive eruptions have occurred at Mount St. Helens for more than 40,000 years. Each of the bars above represents one or several closely spaced eruptions that occurred within the past 4,000 years, including the latest series from 1980 to 1986.



SCORCHED ZONE

As hot as 400°F, searing gases killed the living tissues of trees in a narrow fringe around the blast area. Left standing, the trees now provide a home for woodpeckers as well as mountain bluebirds. Shrubs such as vine maples have resprouted. Seeds of Douglas firs from the surviving forest nearby have blown in and taken root.





Melted snow and ice along with loose material such as sand and boulders formed a concrete-like slurry that mowed down trees in otherwise unscathed valleys. With each rain the surface is disturbed, leaving a chronically disrupted floodplain where alders, Douglas firs, and hemlocks are carried away before they become firmly established.

MUDFLOW

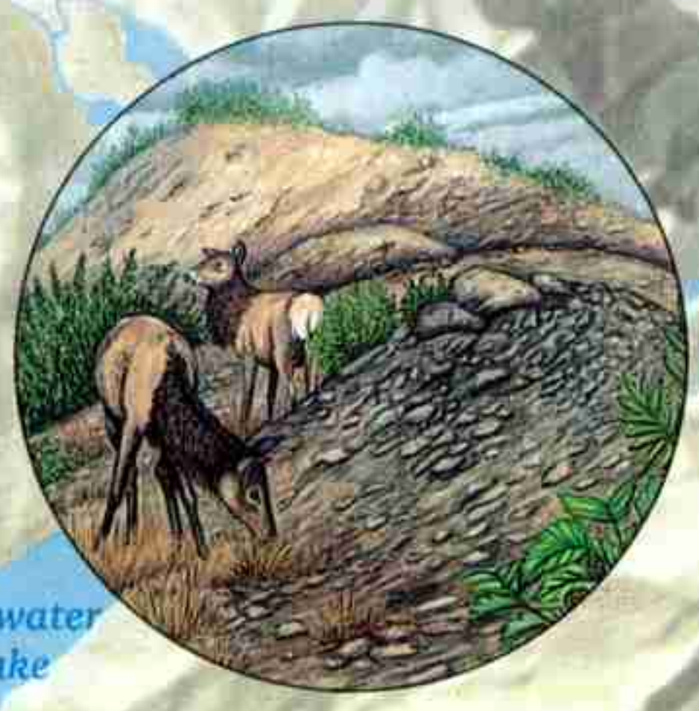
LATERAL BLAST

Gases, ash, and pumice moving more than 200 miles an hour blew down trees and stripped off their branches. Logs now give small mammals and insects cover and foraging habitat. Windblown fireweed seeds sprout and flourish in the ash. Protected from the blast by snow, saplings of trees such as silver firs will reseed the area when they mature.



DEBRIS AVALANCHE

A landslide of material from the top of the volcano and its north slope raced 15 miles down the North Fork Toutle River, settling in hummocks as high as 240 feet. Grasses have grown up in patches, and elk come to graze, leaving seeds of sedges and grasses in their droppings. The roots of alder saplings enrich the soil by fixing nitrogen.



PYROCLASTIC FLOW

Scoured and buried by pumice, the flow area was also sterilized by temperatures that reached 1450°F. In the first few years prairie lupine seeds traveled in on the wind and in runoff after rain. The purple-flowering plants release nitrogen and trap other wind-borne seeds. Animals like the deer mouse moved in once plants offered food and shelter.



Coldwater Lake

Coldwater Ridge Visitor Center

504

South Coldwater Creek

DRAINAGE TUNNEL

Johnston Ridge Observatory

DEBRIS AVALANCHE

Spirit Lake

To Meta Lake (2 miles)

99

Castle Lake

Pumice Plain

PYROCLASTIC FLOW

Windy Ridge Viewpoint

LATERAL BLAST

South Fork Toutle River

Loowit Falls

MUDFLOW

Mount St. Helens
8,363 ft
2,549 m

0 mi 1
0 km 1

ART BY WENDY SMITH
MAP BASE ART BY ROBERT W. TOPE
RELIEF BY TIBOR TÓTH
NATIONAL GEOGRAPHIC MAPS

After the big eruption magma pushed into the crater again and again, building a dome that finally reached 880 feet tall. Though it stopped growing in 1986, the dome still radiates enough energy to heat groundwater. This feeds thermal springs where heat-seeking bacteria, among the oldest life-forms on Earth, now thrive.

THE CRATER

"When the eruption is over, it's not over—the

the crosses, including Ty and Marianna Kearney, ham radio operators from Vancouver. They had fled their watch post west of the mountain just ahead of a speeding wave of ash—and just after receiving a final radio message from Gerry Martin, a fellow watcher: "It's going to get me. . . ."

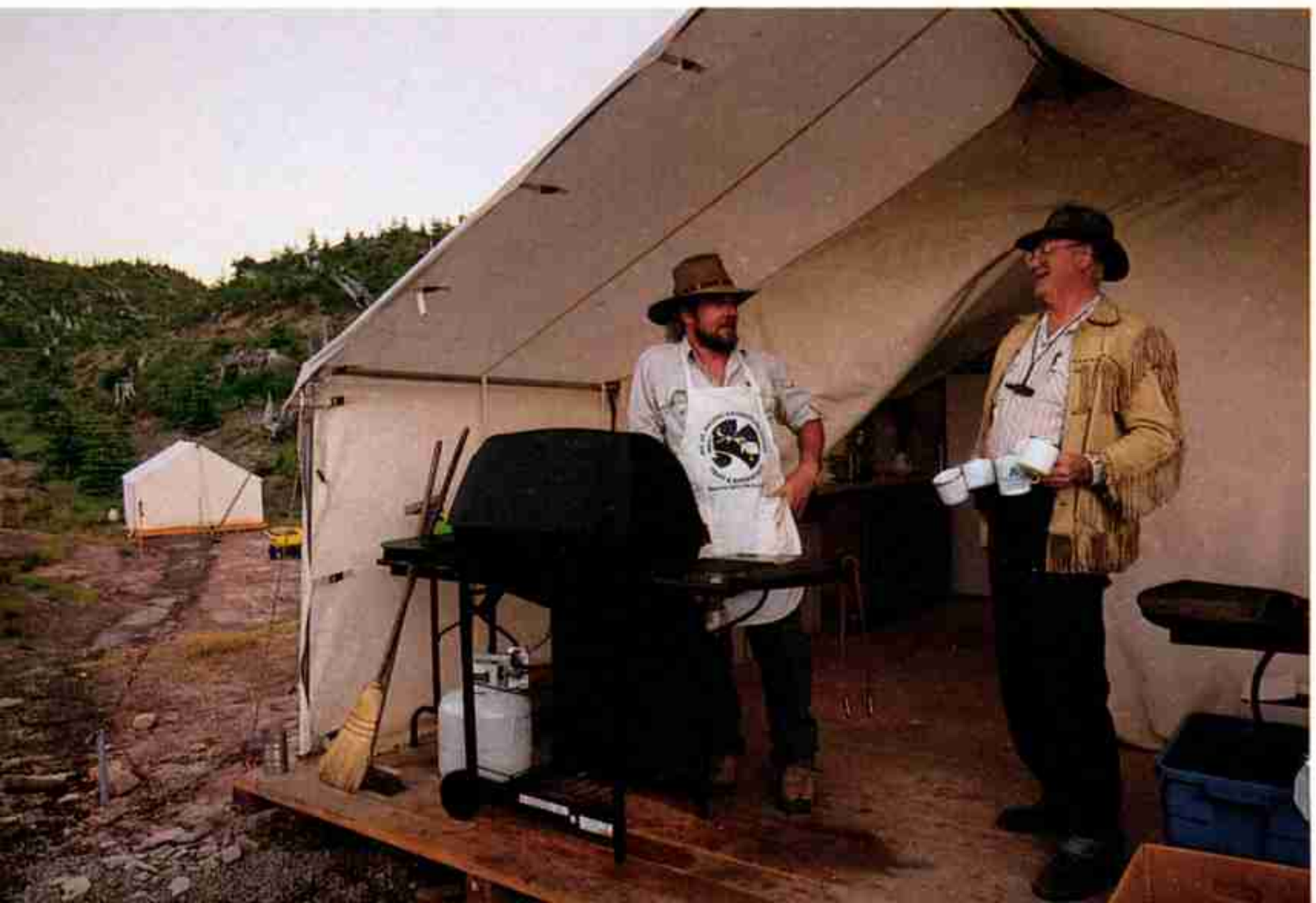
On the first anniversary of the eruption William Parker's truck was retrieved by friends. "They brought it home, blew the ash off the valve covers, and put in a new battery," Donna said. "It started right up. We gave it to them, his fishing buddies, and they restored it. The last I heard it was still running somewhere in Alaska."

The vision of that truck chugging away in Alaska is cheering to those bereaved or traumatized by the eruption. I think I understand this because I became more personally involved in this story than in any other I ever wrote. Another assignment had brought me to the area for the first tentative stirrings of the mountain; then circumstances kept me there. Over a period of weeks I acquired a caring stake in many lives. I knew some people who died, or who lost loved ones or narrowly escaped themselves. I knew that many still had trouble accepting the momentous changes.

From the porch of her home beside Silver Lake, Gladys Dodge Robards, 87, had witnessed the event 30 miles away. As a girl she worked summers at Harmony Falls Lodge on Spirit Lake at the foot of Mount St. Helens, and she loved the area. Her son John had told her about the devastation, including the huge landslide. Among other consequences, the landslide raised Spirit Lake's surface by 200 feet, burying not only the lodge but also its 150-foot namesake waterfall. John wondered why she had never asked to go and see the remade landscape, not even when the Johnston Ridge Observatory opened just five miles from the crater. This visitor center features a 16-minute film on the volcano, then the screen is raised to reveal a giant picture window framing the actual mountain. "One day I just drove my mother to the Johnston Ridge visitor center," John said. "I took her in to see the movie. When it ended and the screen was raised, showing the crater, she cried. I think for the first time she really accepted what had happened."

THERE WAS A MAN who said he'd rather die than see his beautiful mountain blasted into an ugly shell of itself—and he got his wish. Despite many chances to evacuate, Harry R. Truman chose to remain at his St. Helens Lodge on Spirit Lake. He is there yet, together with his multitude of cats and, at last report, 38 bottles of bourbon, all buried under hundreds of feet of landslide debris and elevated lake waters.

For half a century Harry had loved the mountain, communing with it in spirit. "I talk to the mountain, and it talks to me," he would say. He and his wife, Edna, ran the inn for an increasing fan club of vacationers, including the late William O. Douglas, Supreme Court justice, author, and world traveler. Harry's talents included a gift *(Continued on page 121)*

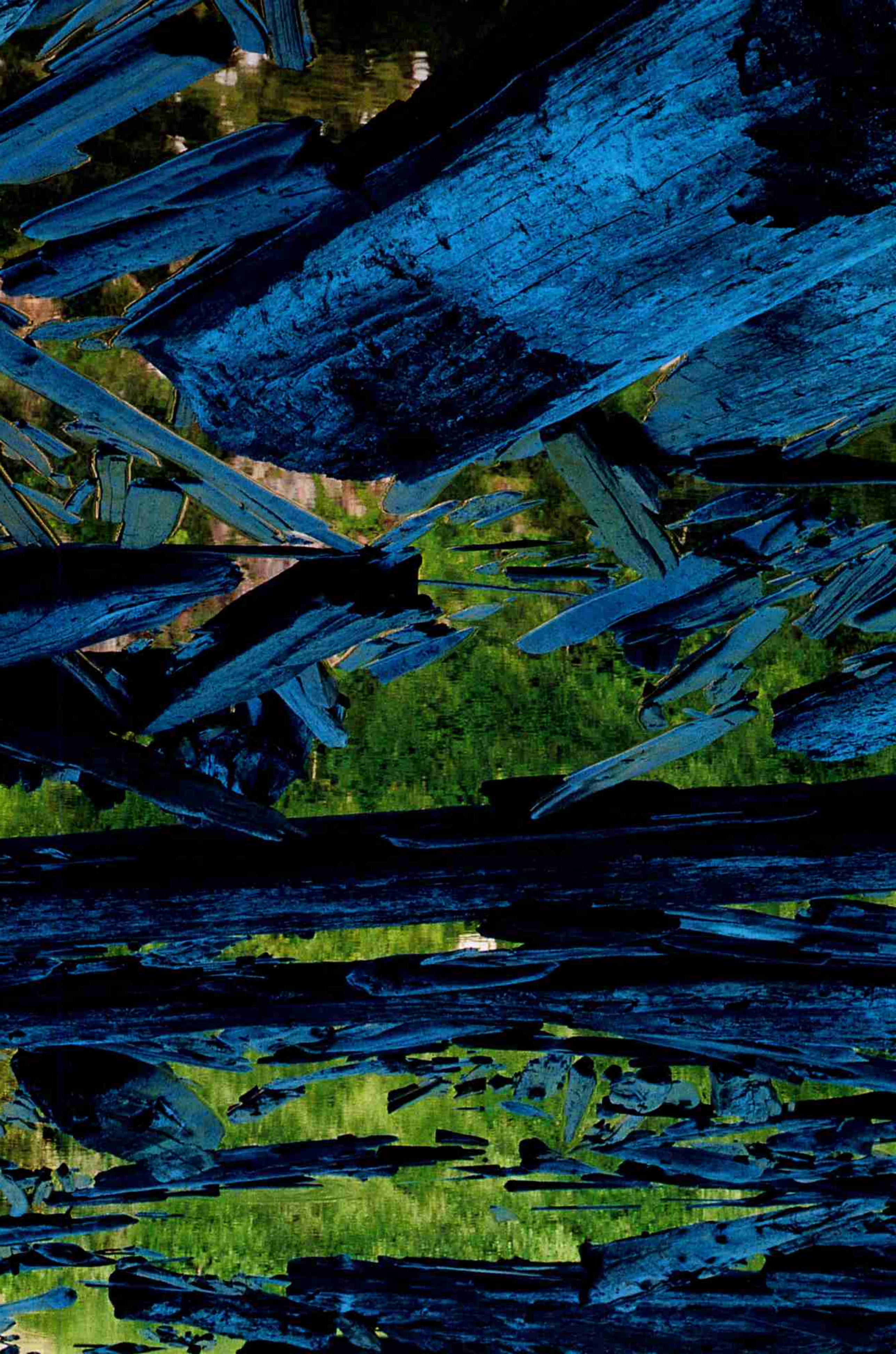


Time is demolishing a car left near Meta Lake by gold prospectors killed in the lateral blast. All told, 57 people lost their lives. Mark Smith (left, at left) and his family lost their livelihood, the Spirit Lake Lodge. Today they run a tent-and-breakfast on logging land just outside the monument. "We haven't abandoned the mountain," he says. "We've learned to adapt and work with it."

consequences go on." — Peter Frenzen



Floating graveyard of a shattered forest, Castle Lake took shape after the debris avalanche dammed up Castle Creek. The water reflects young alder trees, willows, and conifers—the same species growing here before the eruption—that have regreened the land.





for telling stories eloquent with adjectival profanity. In a troopship in World War I he'd survived a torpedoing off Ireland. He was an aircraft mechanic in France, a bootlegger in California during Prohibition.

In the weeks before May 18 I'd come to know Harry, and on my recent return trip I looked up his brother-in-law, D. O. (Buck) Whiting of Kelso. "Edna used to tell Harry he'd become a legend, and Harry would make a joke of it," Buck told me. "Edna died in 1978, and Harry lost interest in keeping the lodge going. Then the first eruptions started in March 1980, and when he said he wouldn't leave his lodge, everybody wanted to talk to him. He enjoyed all the interviews and cameras and helicopters coming to his door. After he died, people wrote songs and books about him, and a Hollywood crew came in and put him in a movie. And we remembered what Edna said."

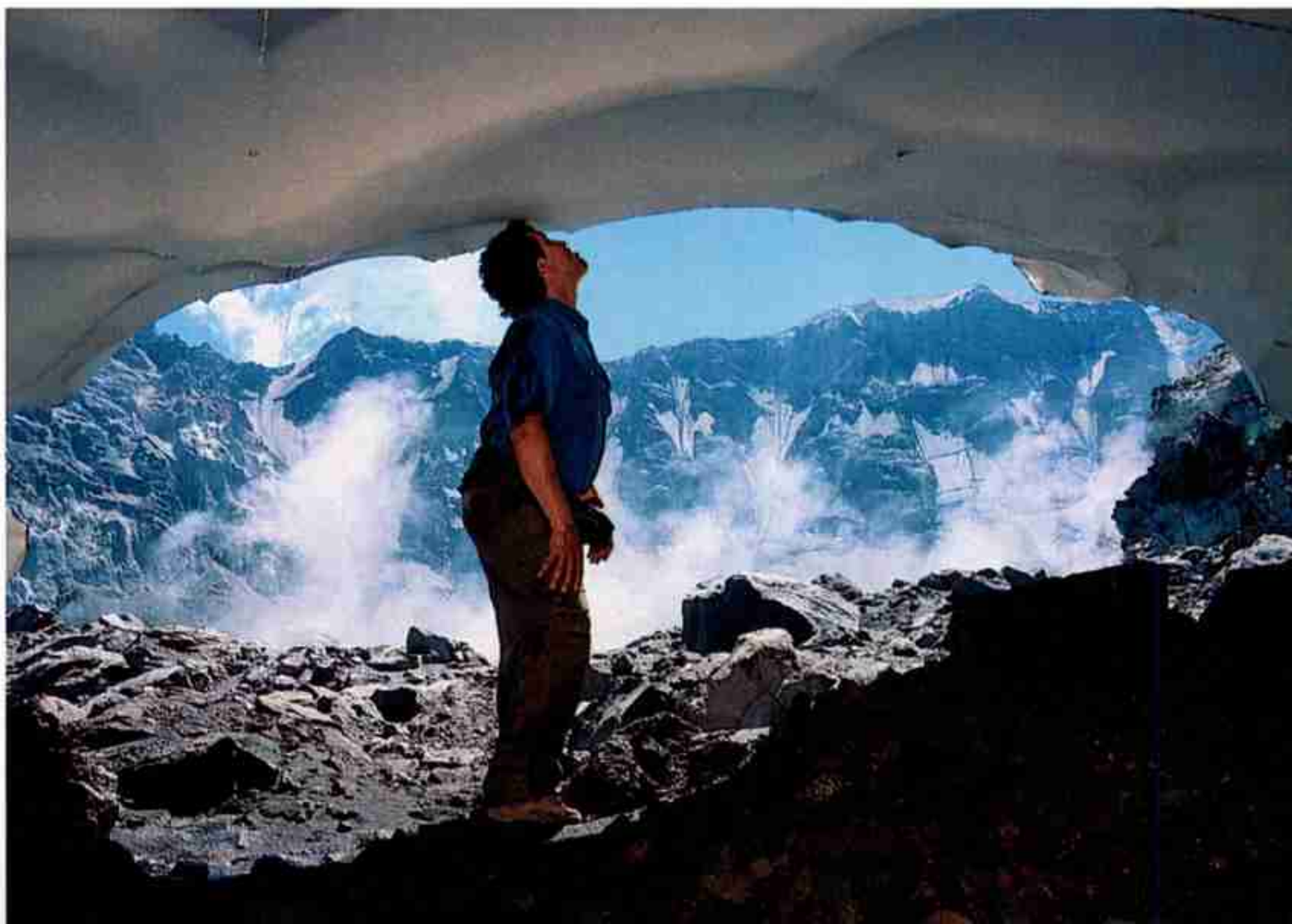
As time passes, others who died keeping vigil on the volcano are becoming part of legend. At an observation site eight miles northwest of the crater, Reid Blackburn, a 27-year-old photographer from the Vancouver *Columbian*, fired off four frames as the destructive wall of gases and ash rushed toward him. Heat ruined his film, and the car in which he took shelter could not save him. His wife, Fay, takes pride in a scholarship fund in Reid's name, which by now has helped 18 aspiring photojournalists.

David Johnston was manning a U.S. Geological Survey (USGS) post five miles northwest of the mountain. Though only 30 years old, he had become expert on explosive composite volcanoes, particularly those in Alaska. David knew the risks, but he was excited at the chance to learn more. It was he who sent the radio message to the world at 8:32 on Sunday morning, May 18: "Vancouver! Vancouver! This is it."

Trailer, vehicle, and gear were blasted off the ridge, and David was never found. He is remembered in the naming of the ridgetop and the visitor center, located close to where he was when he sent that last message, as well as the David A. Johnston Cascades Volcano Observatory in Vancouver, Washington.

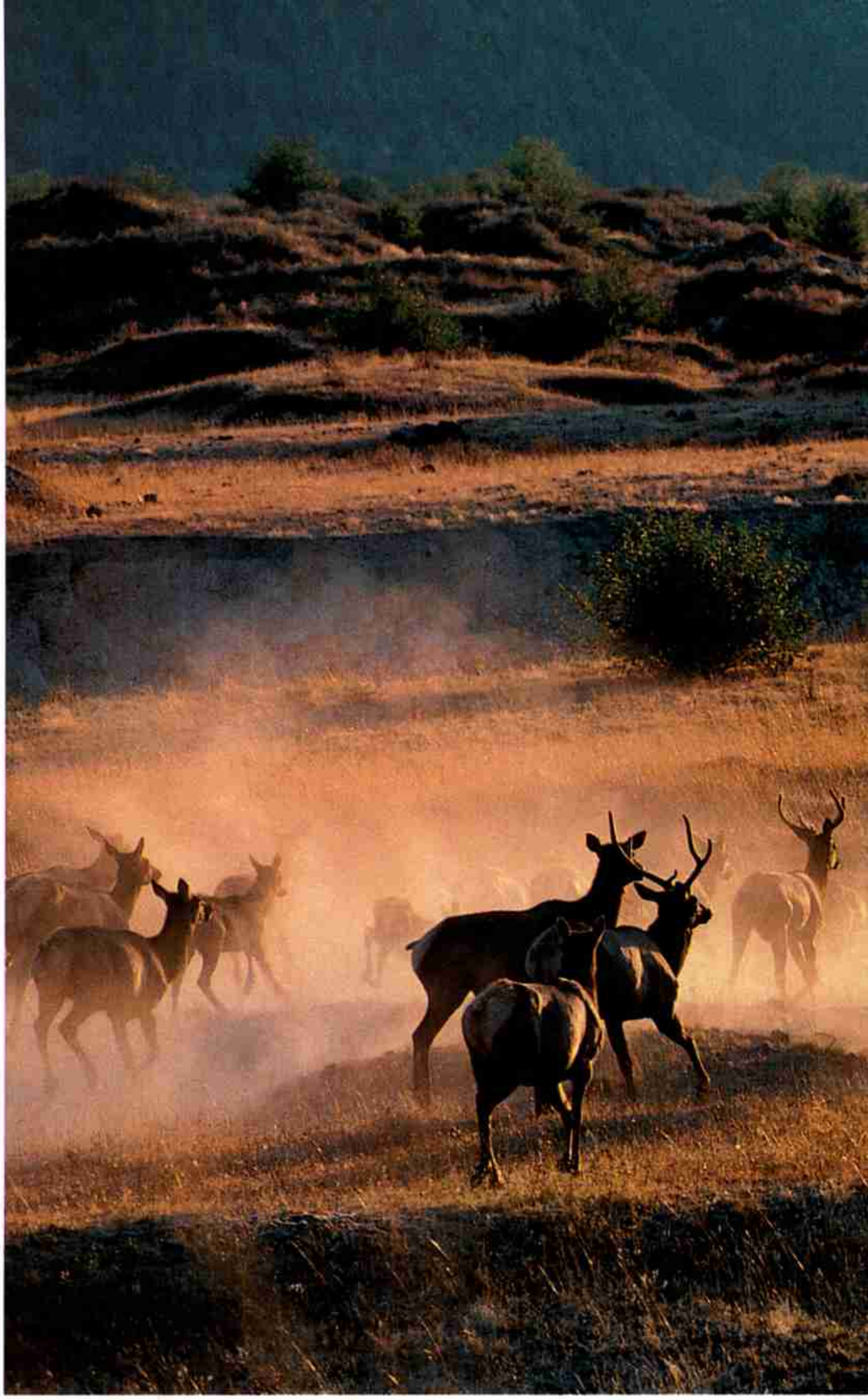
I WENT TO THE OBSERVATORY to talk to Dan Miller, a geologist who had been scheduled to join his friend David Johnston at the monitoring site that fateful morning. Providentially, the need to repair a camera delayed Dan's arrival just long enough to spare his life. Now he heads the Volcano Disaster Assistance Program (VDAP), a small team of experts on volcanoes who are ready to leave on a few hours' notice for any place in the world threatened by an imminent eruption. I shared memories with Dan of 1980's unsettling events, and he told me about his work.

"Mount St. Helens has taught us a lot about how composite volcanoes work," Dan said. "These lessons enable us to forecast the likelihood of an eruption with increasing accuracy. Once our monitoring instruments are installed, we get instant readings by radio. Computers correlate our field data on earthquakes, deformation, and gas emissions. They can indicate magma moving upward inside the mountain. When our graphs of these components produce three upward curves that more or less coincide, the alarm bells go off. With VDAP we can share our experience here with threatened areas, saving lives and property."



Spilling from the crater, Loowit Falls reshapes the north slope of the volcano. "You'd expect a hardrock canyon to be thousands, even hundreds of thousands of years old," says Peter Frenzen, monument scientist. "But this was cut in less than a decade." Fresh snow melting in the crater quenches his thirst; accumulations in an area of constant shade are gradually forming a glacier.

Majestic symbols of recovery, elk cross state land planted with grasses and clover to give the animals forage. Nearly 2,000 died in the eruption, but reseeding efforts, several mild winters, and a ban on hunting in some areas have helped increase herds back to 1980 levels.



Unlike small creatures, big animals had no place to

An eruption in Colombia in 1985 was the catalyst for the program. A remote Andean peak called Nevado del Ruiz showered scorching ash and rock onto glaciers, and the resulting meltdown set off tremendous mudflows that sped down ravines and watercourses. Some 23,000 people died in one village. But they might have escaped death if they had been warned to flee in time. It was this realization that prompted USGS and the U.S. Office of Foreign Disaster Assistance to create VDAP.

The team has already responded to more than 20 calls from around the world, with greatest success in the Philippines. A string of volcanoes, among them Mount Pinatubo, beads the west coast of Luzon, the largest and most heavily populated of the islands. These peaks are part of the Ring of Fire that encircles the Pacific Ocean and includes the volcanoes of Alaska and the Cascades. In early April 1991 Pinatubo began a pattern of small eruptions and earthquakes that gradually intensified. Soon Philippine geologists asked VDAP to join



hide from the eruption.

them in monitoring the volcano, which was developing a pattern strikingly like the one that had preceded the Mount St. Helens blast. By early June, earthquakes beneath Pinatubo showed magma was on the move. Previous eruptions had unleashed fiery gases and mudflows down the mountain's flanks and over broad alluvial plains. The imperiled area included the homes of half a million people of central Luzon. Only 15 miles from the summit lay historic Clark Field, a key American air base predating World War II. On the advice of scientists, phased evacuations began.

On June 15 Pinatubo's build-up culminated in an eruption ten times as big as Mount St. Helens's, a blowout that left a caldera more than a mile wide. But some 100,000 lives had been saved, as well as millions of dollars' worth of aircraft and equipment. "Pinatubo was a big satisfaction to us," Dan Miller said, "a reward for years of research and hard work."

The team's job also involves risking life and limb to get instruments in place for monitoring reawakening volcanoes. Until the data readings begin to come in, a volcano poses a peril of unknown dimensions. I asked Dan how he feels about this.

"We call it mooning the cheetah," he said, citing a Gary Larson "Far Side" cartoon. It depicts a man sadly examining his lacerated hind side, while his wife disparages his judgment in tempting fate once too often.

When the Mount St. Helens eruption sent mudflows surging down the Toutle Valley, on through the Cowlitz River, and into the mighty Columbia, it became a concern of the U.S. Army Corps of Engineers. The resulting silting so filled the Columbia's shipping channel that oceangoing vessels were marooned. The Army engineers' responsibility includes keeping the nation's shipping channels open, so they not only dredged the river channels but also took a hard look at new lakes in the upper Toutle watershed, created by deposits of mudflow debris across side canyons. The biggest are Coldwater and Castle. Because their natural dams might wash out, causing new mudflows downstream, the engineers stabilized both the barriers and their outlet channels. For the same reason they also bored a 1.5-mile overflow tunnel from Spirit Lake through a mountain into the Coldwater Basin. Without the tunnel Spirit Lake would continue to rise and surge over a loose jumble of volcanic debris left by the eruption's landslide. That could trigger another massive mudflow, a replay of the 1980 disaster.

Primeval mats of algae by the Toutle River are harbingers of regrowth. Needing full sun and mineral-rich waters, they settled in soon after the eruption but will die out as saplings spread shade along the riverbanks. So begins the long process of re-creating ecosystems.

ON MY LAST DAY around the mountain I visited the southeast side, where one of the mudflows bared unexpected evidence of an old eruption. As the muddy tide scoured out a deep ravine, it revealed the fluid lines of a prehistoric eruption that had ejected streaming lava. A walking trail offered pleasing contrasts of dark sinuous rock with a tumbling high-country creek against a backdrop of fir and late summer wildflowers. As I drove away, my final look at the mountain was of new snow, pristine white against dark lofty slopes, spotlighted by sun through swirling clouds.

Lower and nearer to me, desolate slopes sprouting new life extended to the edge of untouched forests. The resilience of creation comforts me, because I long for the ultimate return of what was here before—unmarred, stately high-country forest and sparkling streams. We call that process "recovery," but it is actually just one cycle in nature's wheel of perpetual change, in which everything that was comes round again. In the turning some species drop away, some new forms appear. But life's amazing will to survive is equal to volcano, earthquake, ice sheet, and flood. Mount St. Helens has erupted about once a century, often on a much bigger scale. Most of the peak we see today is just 4,000 years old, an infant in geologic time.

Our exit road takes us through Cougar, whose main street just doesn't look right to me without the Wildwood Inn. In 1980 its proprietors, Mort and Sandy Mortensen, served world-class fried chicken. Mort died eight months ago after a long battle with failing health. More recently fire destroyed the landmark restaurant. But Sandy has survived her loss and is finding life good again. My wife, Virginia, and I enjoyed visiting her, and the talk drifted to those late-spring weeks between the volcano's first belch and the big one, when the town bustled with news media and things got a bit crazy.

The Wildwood Inn became a hub for the hungry, thirsty journalists drawn in from afar to monitor the mountain. "Someone was always trying to interview me as I worked, and sometimes I'd just say something ridiculous," Sandy recalled. "One evening when I was very tired, someone put a microphone in my face and asked me how I knew the mountain would erupt. I said, 'Because I saw 40 Bigfoots going through town last night, each carrying a suitcase.' A man at the counter got up immediately and went to the phone. Next day I found myself quoted in the *New York Times*."

Bigfoot, or Sasquatch, the legendary giant—half man, half beast—leaves huge footprints. None have been reported lately, so maybe he did relocate. If so, Bigfoot, you are missed. Please come home. □

Natural disasters like Mount St. Helens humble us with the power of nature. How do people cope? Share experiences at *www.nationalgeographic.com/ngm/0005.*





PHOTO-ART COMMERCIAL STUDIOS

■ FROM THE GEOGRAPHIC ARCHIVES

Peak Experience

The peaceful waters of Spirit Lake enjoyed by these swimmers in the 1940s would roil a few decades later, when Mount St. Helens—in the background—erupted on May 18, 1980. An avalanche of rock and ash turned the evergreen wilderness into moonscape and dammed the lake's southern shore, raising the water level 200 feet. Twenty years later old-growth tree trunks that were scoured off the mountainside still float raft-like on Spirit Lake, now part of a research area closed to recreational users.

This photograph has never before been published in the magazine.



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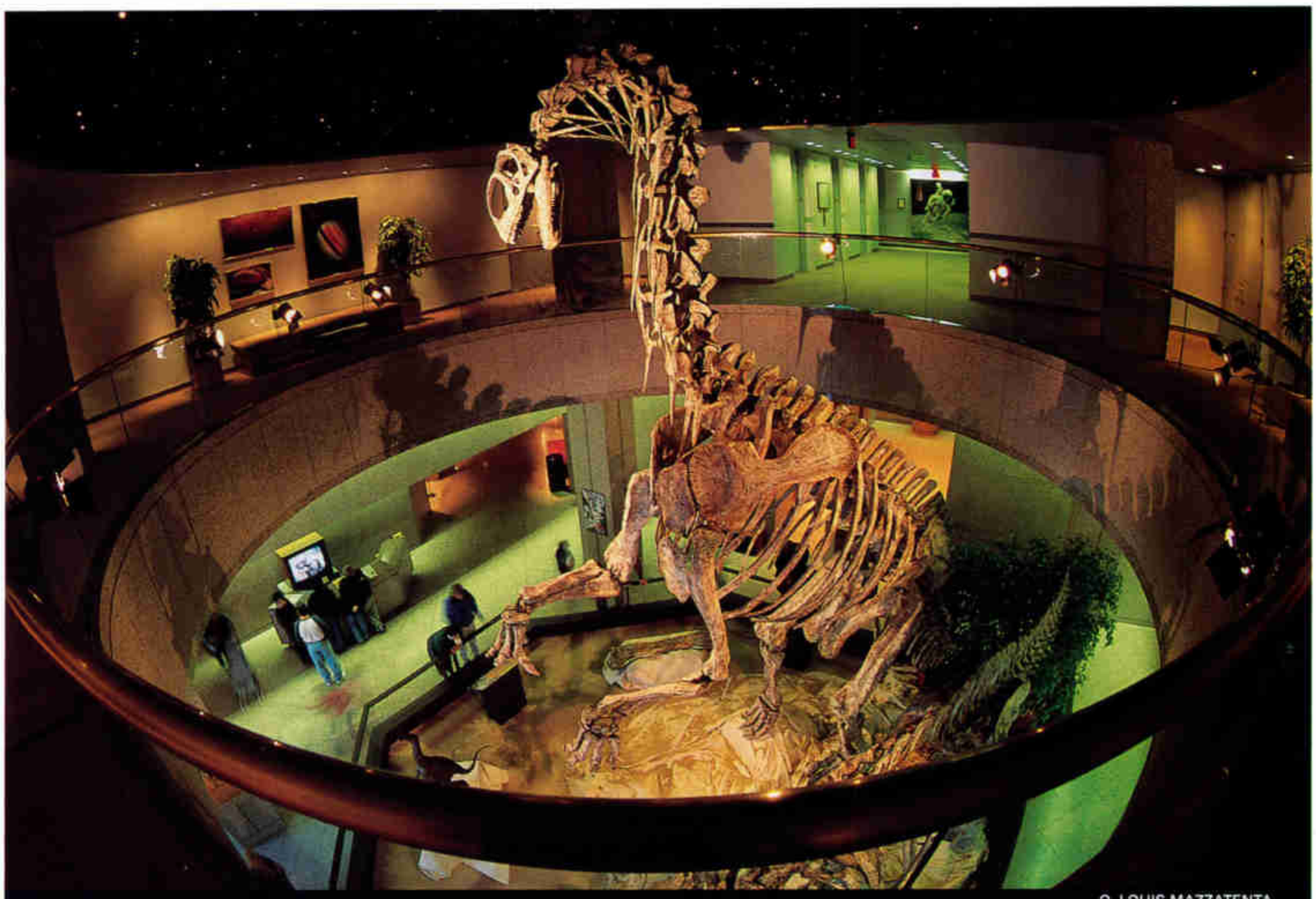
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NATIONAL GEOGRAPHIC

Behind the Scenes



O. LOUIS MAZZATENTA

Boning Up on Dinosaurs

The dinosaurs are back at Society headquarters. They visited last November (above), and in early April, 17 crates of fossilized-bone casts were again unpacked and assembled to create skeletons of an adult and a juvenile *Jobaria tiguidensis*, both unearthed in the Sahara in 1997 by paleontologist and Society grantee Paul Sereno and his team. The newly discovered species was a plant-eater the size of *T. rex* and roamed in herds through African forests 135 million years ago. At 26 feet high, the larger *J. tiguidensis* clears the starry ceiling of our M Street building by just six inches. The skeletons will be on display until May 31.

Image Not Available

JAMES KEGLEY

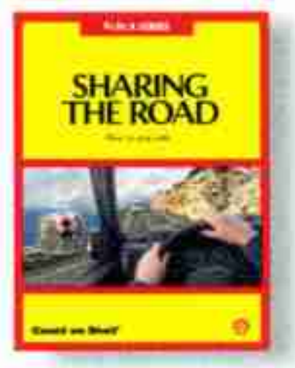
He's Got a New Altitude

Longtime Society contributor Brad Washburn was on top of the world as he perched on a model of Mount Everest in our Explorers Hall last November. The man responsible for the most accurate map ever made of Everest was here to announce its newly revised height.

Society-sponsored scientists had put GPS (Global Positioning System) equipment atop the world's tallest mountain for a more accurate reading. The new figure? A seven-foot increase: 29,035 feet.



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Like Grandfather, Like Grandson

The Society's highest honor, the Hubbard Medal, was presented to round-the-world balloonists Brian Jones (right, at left) and Bertrand Piccard, at right, last November. Piccard's father, Jacques, at center—an oceanographer who wrote our "Man's Deepest Dive" story in August 1960—attended the award ceremony as well. His own father, Auguste, was also a famous balloonist. He ascended a record ten miles into the stratosphere in his craft and was featured in the March 1933 issue. "For all my life I was so proud to be my father's son," said Jacques. "Now I am also proud to be my son's father."



SAM KITTNER



SISSE BRIMBERG

Our Local Hero

Priit Vesilind was just a toddler when his parents fled the Soviet invasion of Estonia in 1944. His family eventually settled in Pennsylvania, and Priit grew up to be a senior writer for National Geographic. Though suppressed by his homeland's then Communist government, his April 1980 article, "Return to Estonia," was an underground hit in that country. Now Estonian television has made an hour-long documentary about him. "People bought the issue for years on the black market or had friends in the States mail them a copy," says the film's assistant producer Valli Voor (left, at center). She and her crew filmed Priit, far right, at work in Estonia for this issue's Viking story—and at play, surrounded by children at the Virginia school where his wife, Rima, is principal. "He's a hero to Estonians," says Valli.

Focusing on Africa



Last fall 13 Grosvenor Council members—each of whom yearly contributes $1,000 or more to the Society—traveled to South Africa to meet paleoanthropologist Lee Berger and glimpse new fossil finds, detailed in this issue. In Botswana they joined staff photographer Chris Johns, who gave tips on capturing wildlife on film. Texan Jim Young (above) bagged this image of grazing zebras.

TEXT BY MAGGIE ZACKOWITZ



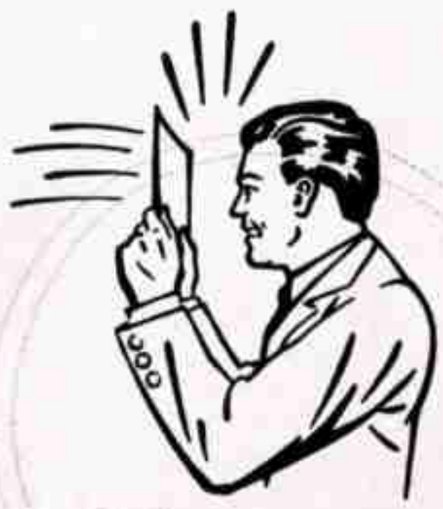
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Mapping Tornadoes' Deadly Paths

The arrival of spring is a mixed blessing for residents of the Tornado Alley states of Texas, Oklahoma, Kansas, Nebraska, and Iowa. About a third of U.S. twisters occur there, when cold air from Canada clashes with warm, moist winds from the Gulf of Mexico, producing tornado-breeding thunderstorms.

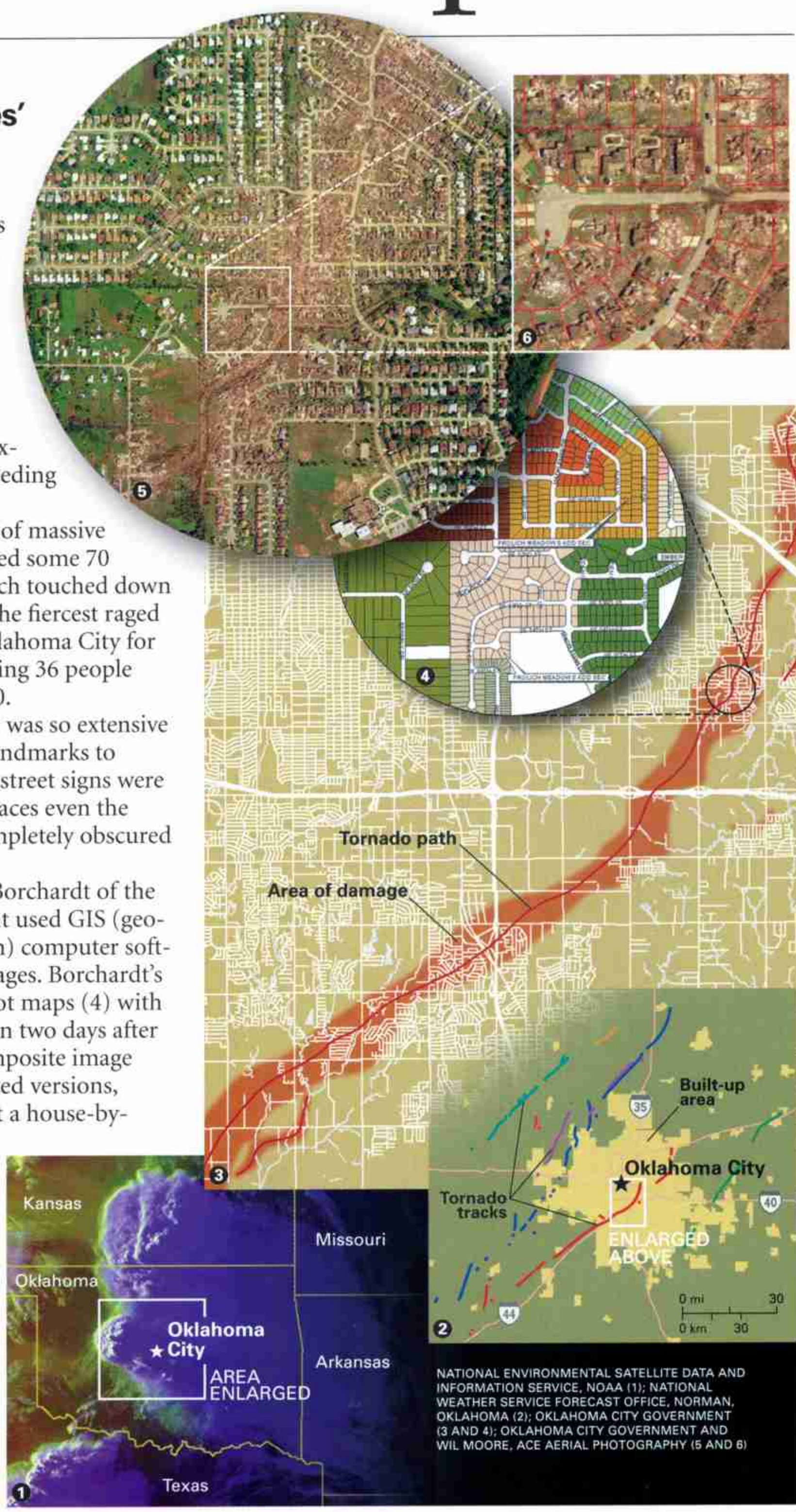
On May 3, 1999, a series of massive supercell storms (1) spawned some 70 tornadoes, about 60 of which touched down in central Oklahoma (2). The fiercest raged through the suburbs of Oklahoma City for more than an hour (3), killing 36 people and injuring more than 300.

The twister's devastation was so extensive that rescue teams had no landmarks to guide them. Addresses and street signs were swept away, and in some places even the streets themselves were completely obscured by wreckage.

To aid rescuers, Bobbie Borchardt of the Oklahoma City government used GIS (geographic information system) computer software to meld maps and images. Borchardt's staff combined street and lot maps (4) with aerial photographs (5) taken two days after the storm to produce a composite image (6). Rescuers received printed versions, which they used to conduct a house-by-house accounting of missing people.

Before the storm, radar provided early warning—luckily during hours when people were awake—that saved hundreds of lives. Without it, the rescuers' search would likely have been much more grim.

TEXT BY
ALLEN CARROLL
Chief Cartographer



NATIONAL ENVIRONMENTAL SATELLITE DATA AND INFORMATION SERVICE, NOAA (1); NATIONAL WEATHER SERVICE FORECAST OFFICE, NORMAN, OKLAHOMA (2); OKLAHOMA CITY GOVERNMENT (3 AND 4); OKLAHOMA CITY GOVERNMENT AND WIL MOORE, ACE AERIAL PHOTOGRAPHY (5 AND 6)







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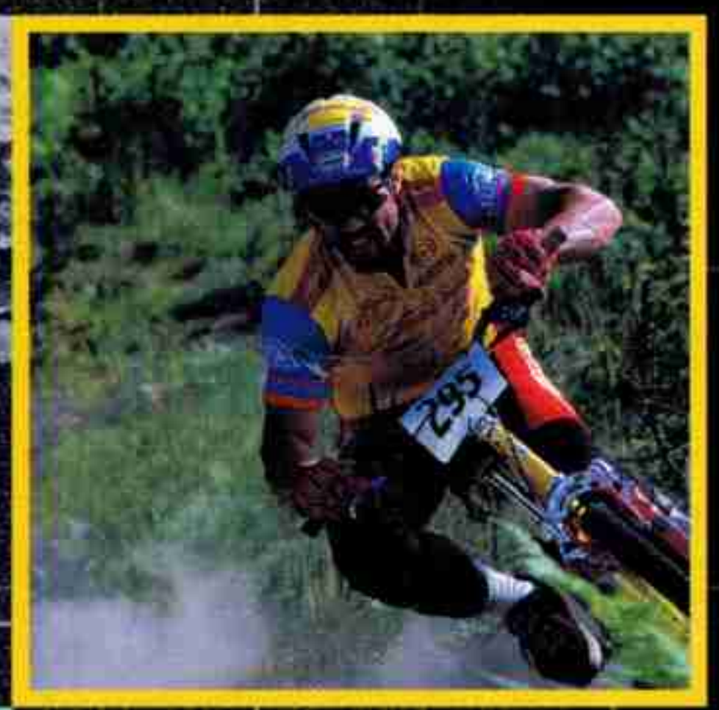
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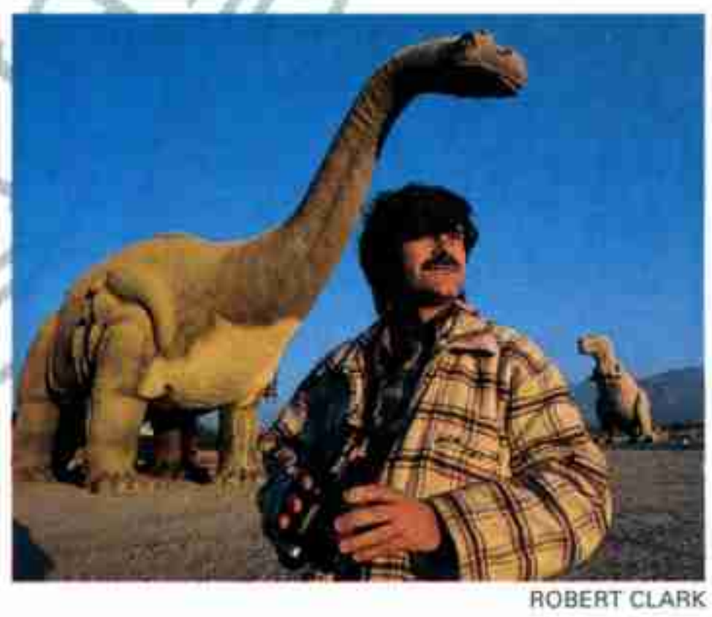
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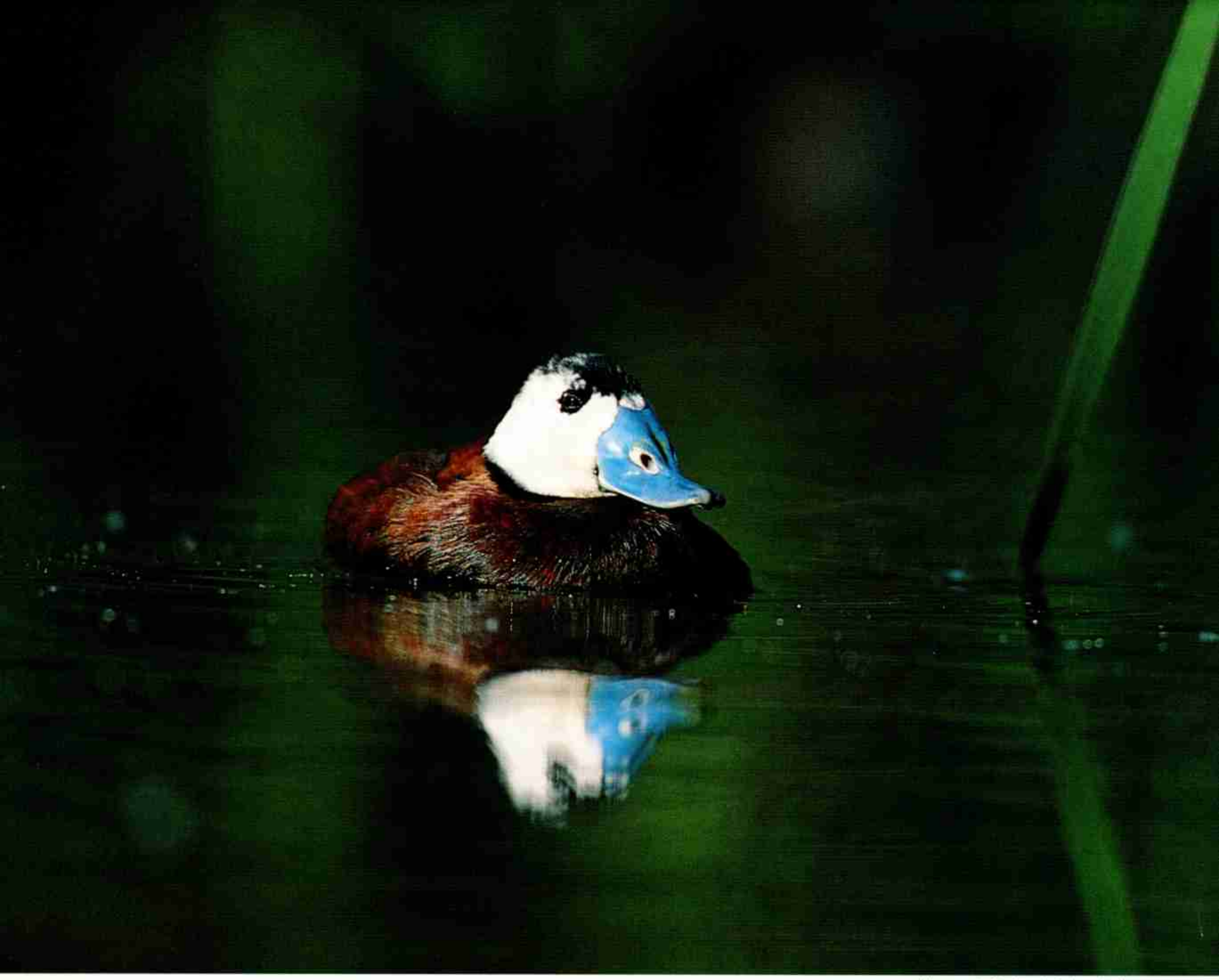
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Photographed by Antonio Sabatar Artús

WILDLIFE AS CANON SEES IT

The bill of a male white-headed duck turns from brown to a vivid sky-blue during breeding season. The duck's characteristic broad bill and its elongated and pointed tail feathers identify this species as a stifftail—a distinct waterfowl group most adapted to an aquatic environment. The stiff tail helps the duck maneuver underwater while foraging. In the silty bottom, the duck feeds on tiny midge larvae, its main food, and on other invertebrates and seeds. White-headed duck populations have dwindled due to habitat loss and hunting; in Europe, hybridization with the introduced North American ruddy duck is now the greatest threat.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.



White-headed Duck *(Oxyura leucocephala)*
Size: Length, 43-48 cm
Weight: 510-820 g
Habitat: Shallow, brackish or fresh water lakes and lagoons; fragmented range across west Palearctic and western Asia
Surviving number: Estimated at 10,000 and declining

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*Based on The Polk Company calendar years 1997, 1998 total passenger car registrations. 1999 based on manufacturers' sales data. **Customer loyalty based on the number of owners who replaced a vehicle with a new vehicle of the same model, based on a sampling of personal-use new-vehicle purchases and leases from 10/98 – 9/99.